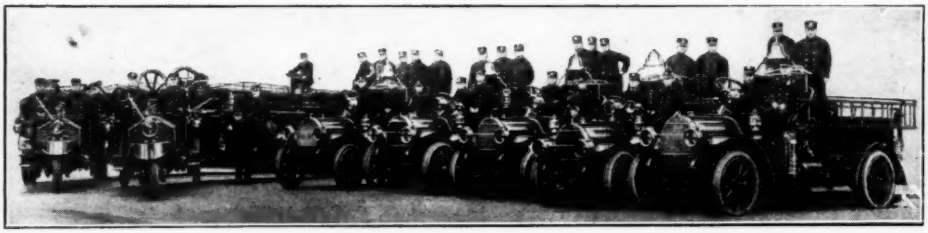
# MUNICIPAL ENGINEERING

**The World's Leading Municipal Publication.**



PART OF THE MOTOR EQUIPMENT *in the Pittsburgh Fire Department. This city now has sixteen pieces of Knox equipment, consisting of ten combination cars, like those shown in the right of the picture, and five Knox-Martin Tractors attached to hook and ladder trucks and steamers.*

VOL. XLVI. MARCH, 1914. NO. 3.

## INDUSTRY.

*If you have great talents, industry will improve them; if moderate abilities, industry will supply their deficiency. Nothing is denied to well-directed labor; nothing is ever to be attained without it.*

*—Sir Joshua Reynolds.*

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# MOTOR DUMPING TRUCKS

## AMERICAN AND GERMAN TYPES

*Convenience and adaptability of the dumping apparatus to the uses of the motor truck are prominent factors in the design of modern vehicles for carrying bulky materials. This brief article gives illustrations of a few prominent results of intelligent designs in America and Germany.*

THE modern motor dumping truck for handling coal, sand, ashes or garbage is a most economical and labor-saving device and it may be of interest to note some of the types of dumping cars used in this country and in Germany. The accompanying diagrams show five American designs of tipping gear adopted by leading motor truck builders.

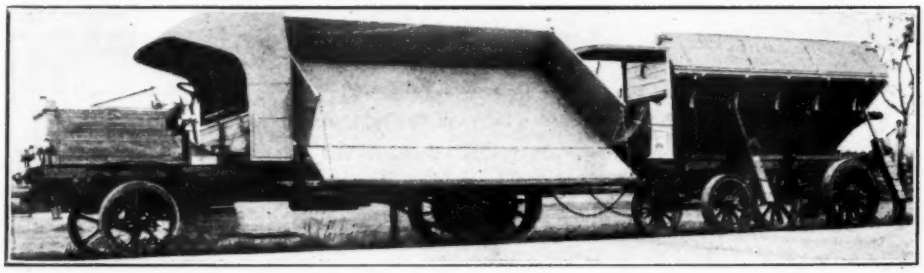
The photograph (Fig. 2) shows a motor van of the Buessing type designed at Braunschweig, Germany, in which ashes and garbage can be collected by the same motor truck without mixing. Dumping can be done on either side from two or four compartments. The photograph (Fig. 3) shows a similar German truck for ashes for dumping on either side with a trailer also dumping at side for the separate collection of garbage. The accompanying illustration (Fig. 4) shows a German end-dumping truck for handling sand.

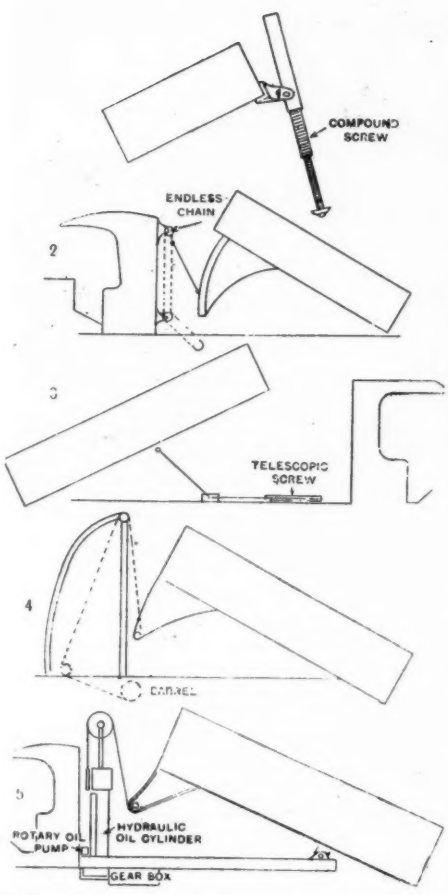
In all industrial enterprises, in agriculture, in the army, whenever the question of transportation is one of great importance, the motor van is rapidly replacing the horse-drawn vehicle, and is destined, moreover, to be a most useful substitute for the railway in conveying material and goods safely and cheaply. The motor van is distinguished by its remarkable ease and freedom of motion, notwithstanding its 3 to 10-ton loads. Transportation by motor van insures a considerable saving of expense as compared with conveyance by railway, and also a considerable saving of time, as the troublesome loading and discharging of goods into or from railway cars, storage in depots and other delays are avoided.

The German motor trucks of the Buessing type with 4 and 5-ton chassis for heavy motor truck and road train service are equipped with gasoline engines of 35 and 40 horsepower. They have spring connecting rods between frame and rear axle and double suspension of the front axle. The frame is supported on the plate spring ends with ball pivots.

The straight frames of all vehicles are fitted with longitudinal bearers of

A GERMAN MOTOR TRUCK AND TRAILER *for ashes and garbage collection, dumping on either side.*






TIPPING GEAR *for various American motor trucks;* (1) *Peerless,* (2) *Mack,* (3) *Locomobile,* (4) *Alco,* (5) *Pierce-Arrow.*

U-rolled section and the transverse bearers are made of pressed sheet steel. Frames of this kind, besides great bearing power, supply a considerable resistance to the torsion arising and are not heavier than pressed sheet steel frames.

The roller bearings and ball pivots serve at the plate spring ends of the rear springs for supporting the frame. Strong spiral springs between the frame and front plate springs absorb violent shocks.

The 4-cylinder engine supplying the driving power was designed especially for reliability in service, economical consumption of fuel, steady motion and strength. The controlled inlet and outlet valves are mounted on separate valve seats, so that when the faces of the valve seats wear the whole cylinder need not be replaced, but only the worn valve seat.

The carbureter is distinguished by its economical consumption of fuel with no sensitive automatic parts.

The fuels used are gasoline, benzole, heavy petrol and similar heavy fuels. As to governing, it may be stated that the speed is regulated by throttling the gas mixture, either automatically by a centrifugal governor or by the driver himself. The throttling means operated by the driver are connected to the rods of the governor in such a manner that the driver can change the speed of the motor only when the number of revolutions is below normal.

For ignition a magneto serves as source of current and is mounted on the motor in an accessible and easily interchangeable manner. This ignition is absolutely reliable, it is claimed, and is also sufficient under all circumstances for starting the motor.

Water circulation is by centrifugal pump, and the radiator comprises a system of interchangeable flat tubes and is closed at top and bottom by a water box. This German motor is supplied with positive lubrication by oil pumps, which feed the oil to the lubricating places proportionately to the speed of the motor. With regard to long-distance journeys, these pumps always deliver fresh oil with full lubricating capacity to the piston pins, cylinder walls and crank shaft bearings. After passing thru the bearing parts the unused oil is collected below in the crank case, where it serves for cooling the small or top ends of the connecting rods.

The motor is connected to the transmission by a detachable cone clutch, which is operated from the driver's seat by a clutch pedal. The clutch is automatically disengaged by using the foot brake. The power is transmitted from the clutch by a flexible shaft to the transmission gear and differential gear and thence by chains to the rear wheels.

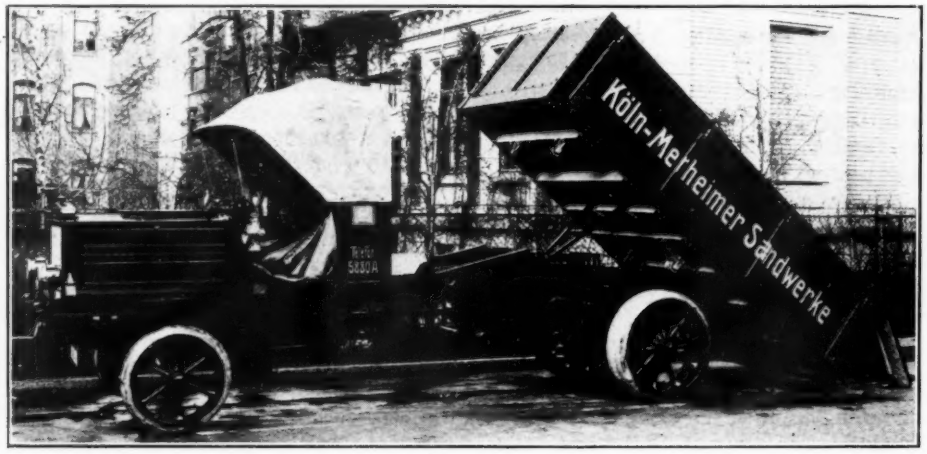
To obviate the starting of the machine by unauthorized persons a lever with a padlock is provided locking the foot pedal of the clutch.

GERMAN MOTOR TRUCK *with four compartments for separating ashes and garbage, dumping on either side.*

Each vehicle has two independently acting brakes, each being capable of braking the vehicle within the shortest possible space and bringing it to a standstill on steep roads. Special care has been bestowed on a satisfactory distribution of the load, so that the rubber-tired wheels are not overloaded. The rear wheels have much less load than the permissible maximum load of other similar types, while the front wheels are loaded correspondingly higher and therefore have a much stronger section than that usual for similar types of cars. This proper adjustment of the load contributes in a high degree to the preservation of the rubber tires and results in an economical service.

These German trucks are fitted with cast steel wheels for rubber tires and with devices allowing the mounting of a non-skidding device. On the motor truck the chassis for useful loads of 4 tons and 5 tons have narrow rear-wheel tread so that no difficulties arise in driving thru gateways. The trucks can also be readily driven on worn-down roads in the track left by other vehicles, and iron tires are often used on trucks of low speed.

BUESSING DUMPING MOTOR TRUCK *for hauling sand, with rear dump.*



# PROTECTION of GIRDERS from LOCOMOTIVE SMOKE

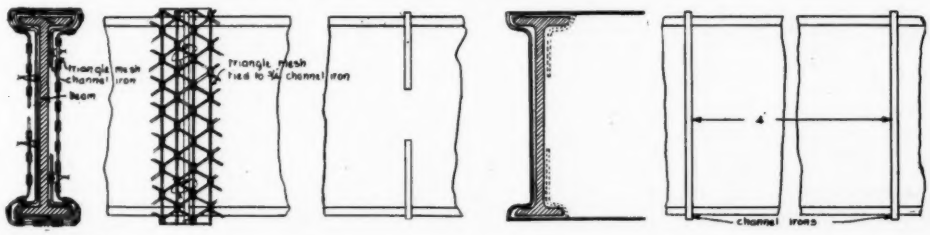
**By H. K. McCay, City Engineer, Baltimore, Md.**

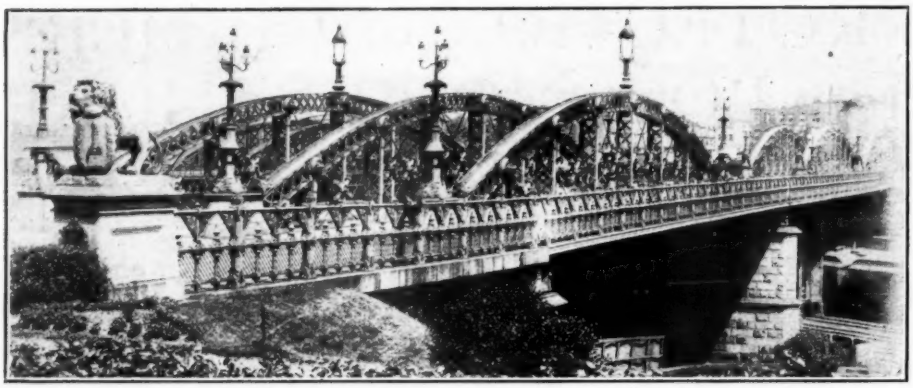
*This brief illustrated description of the latest effort of the city of Baltimore to protect steel viaducts over railroad tracks from the detrimental action of the gases and cinders from locomotives shows the advances which have been made in solving this difficult problem. The efficiency of the method and the quality of the work done will be tested very quickly, for it takes but a few months to produce very serious effects upon an unprotected girder.*

THE city of Baltimore is divided by a stream of water which flows from the northwest to the southeast, thru the most populated districts of this city. The various railroads have utilized the valley of this stream for the purpose of ingress to and egress from the city, laying their tracks along and parallel therewith. Union station, used by the Pennsylvania, Western Maryland and Northern Central railroads, is practically on the banks of this stream. In order to carry the north and south streets in Baltimore across this stream and across the railroad tracks it was necessary to construct at a great deal of expense, five bridges, namely: Guilford avenue, Calvert, St. Paul and Charles streets, and Maryland avenue. Most of these bridges span the railroad tracks at a height which prevents the gas from the engines destroying the steel, but on two bridges, namely, the Calvert and St. Paul street, the clearance is such that the blasts from the engines destroy any protection that is put over the lower members to protect them.

The Calvert street bridge is a magnificent structure, 62 feet in width, with a total length of about 600 feet. The spans are the bow spring type of truss, and made almost entirely of wrought iron. This bridge was built in the year 1878, and cost approximately $220,000. There is a clear span over the railroad tracks of about 146 feet, and a clearance over the Pennsylvania tracks of 23 feet. I found, as stated above, that the lower members of this bridge became badly corroded from the gases of the locomotives, as many as five hundred of these engines passing under this bridge each day. It had been the practice of the city engineer's department to paint these bridges each year, either with coal tar paint or with the very best red lead paint obtainable. I also found it was nearly impossible to use the ordinary scaffolding to allow time for the paint to harden, therefore, I constructed a closed scaffolding, and swung the same beneath the bridge, cleaned off the lower

SKETCH *showing method of attaching the coating of cement to the girder to be protected.*





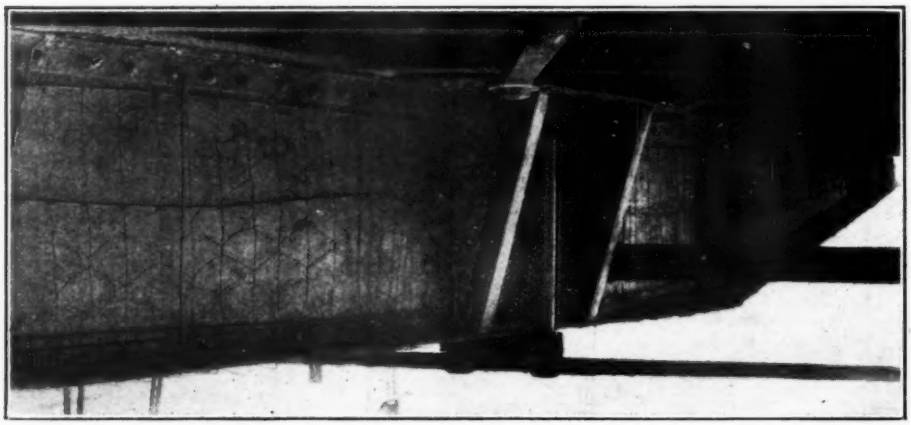
CALVERT STREET BRIDGE *over railroad and creek. A steel bridge, where girders beneath the floor were always in serious danger of corrosion by locomotive smoke.*

members very carefully and repainted with two coats of paint, allowing the scaffolding to remain as a protection for a week or ten days until the paint thoroly hardened. In spite of all this protection, it was found that the paint would not stand the blast from the engines, and the lower members, in order to preserve them, had to be painted each year.

I therefore decided that I would encase the lower members of the bridge in concrete, and careful computation was made as to whether the weight of the concrete would alter the stresses and strains as calculated for this bridge. I found, by removing some ornamental castings, which were of no vital moment to the bridge, that a comparatively thin coat of concrete could be placed on the bridge without increasing the stress or strain, and, if anything, improve the stability of the lower members, thereby reducing to some extent the vibration.

The lower members of the north span consist of nine built-up steel girders, with a surface area of approximately 5,000 square feet. The specifications called for concrete to be put over these members to a thickness of 1½ inches. Sketch No. 1 shows the method of holding the reinforcement to these girders. These girders were carefully cleaned by means of sand blasting and acids, so that all of the old

METHOD OF SURROUNDING GIRDER *with wire to serve as support to retain cement coating in close union with the girder, which was thoroly cleaned of all dirt, rust scale and corrosion before applying the protective material.*



paint was removed, and the steel surface carefully exposed. Wire mesh reinforcement was carried all around the beams, held as shown in Sketch No. 1, and a coat of "gunite," 1½ inches in thickness, was applied; the gunite following the contour of these beams.

Cut No. 2 gives a view of the bridge before treatment.

Cut No. 3 shows the girder on which the reinforcement has been placed preparatory to putting the gunite over the same This reinforcement is held away from the face of the steel by means of ½-inch iron rods, as it was found that the channel method was not satisfactory.

Cut No. 4 shows the same girders after the gunite had been placed on the same by the cement gun, the photograph taken with particular reference to the corner of the reinforcement, showing how the gunite follows the contour of the girder.

The total area, as mentioned above, was about 5,000 square feet for the north span of this bridge, and the contract was let at $1.25 per square foot. An additional area has recently been advertised and the contract let at an expense of 95 cents per square foot.

The grout placed by means of this gun proved very dense and thick and there is absolutely no danger of gases from the engines penetrating the steel thru this grout and I feel satisfied that the city of Baltimore has gotten rid of a very expensive renewal item by the adoption of this method.

I have gone into the details of this work rather more thoroly than necessary so that any other engineer having such a problem may have the advantage of my experience along these lines.

GIRDER PROTECTED BY CEMENT COATING. *Note the corners and how the coat follows closely the contour of the girder.*

# RELIEVING TRAFFIC ON CONGESTED STREETS

By Max J. Welch, Los Angeles, Cal.

*The automobile has greatly complicated some of the problems of street traffic, especially at street intersections and when standing along the curb. This brief article makes some excellent suggestions, applicable to conditions in quite a large number of streets in our large cities, some of them directly and some with modifications to suit local customs and peculiarities.*

THIS discussion and the drawing which accompanies same show a proposed scheme of arrangement of street car tracks, such that pedestrians are not required to cross the trail of automobiles when the pedestrians are mounting and alighting from street cars.

In highway traffic it is customary for the vehicle which travels at the higher rate of speed to pass the vehicle of a slower rate of speed to the left. In the days when street cars traveled faster than the horse and wagon the present system of having the street car tracks in the center of the street was correct.

The automobile has come to stay. The speed of the automobile always will exceed the speed of surface street cars. It is reasonable that the automobiles should pass the street cars to the left-hand side, or the opposite side from which passengers mount and alight from the street cars.

The pessimistic critic who is always devising laws to limit the speed of automobiles is not in harmony with the fast age in which he is living. The point about automobile traffic is not to congest by holding down the speed, but to relieve the traffic by providing safe means for the speedy exit of automobiles.

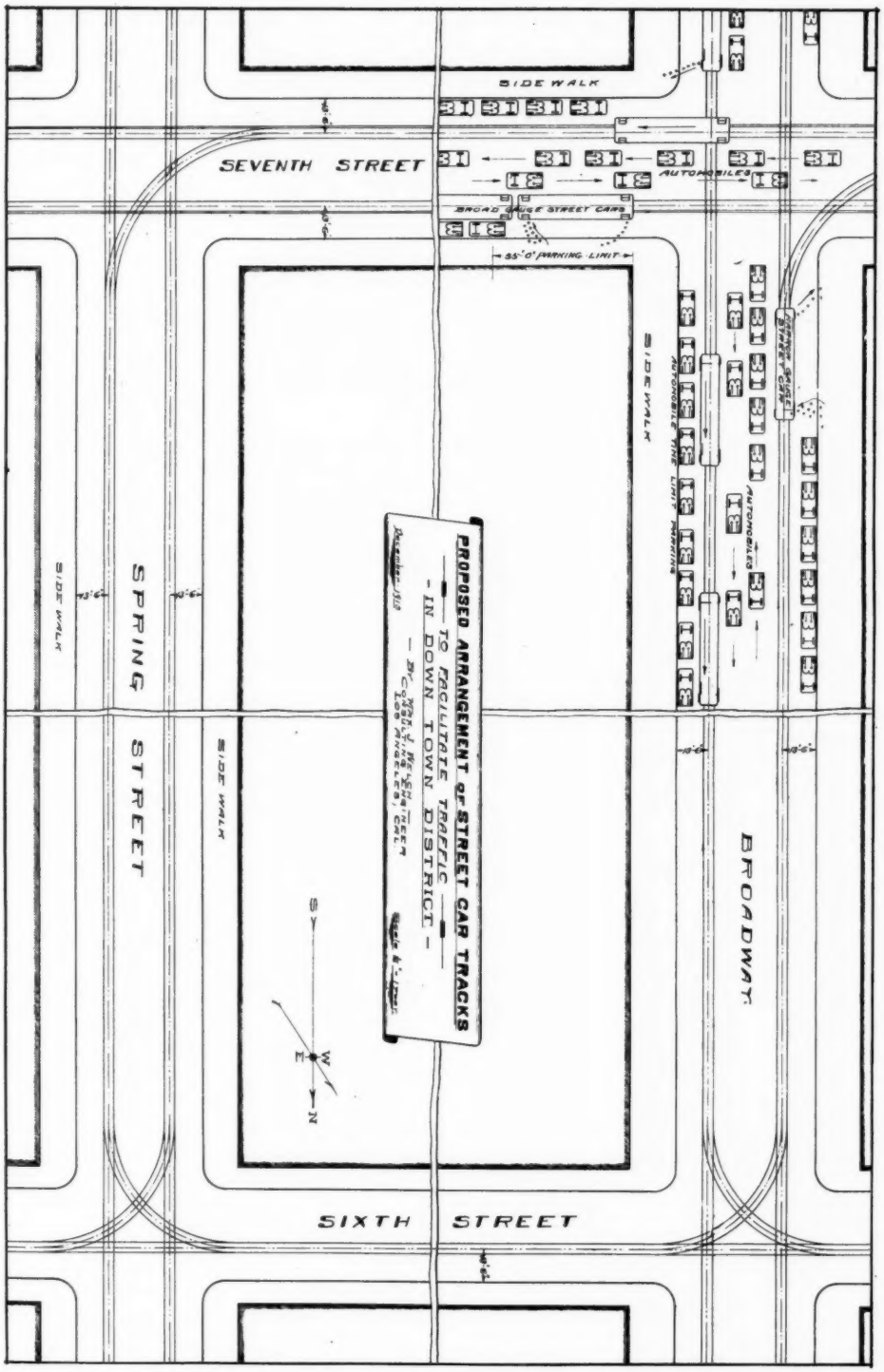
The drawing shows the center of the street car tracks to be 13 feet and 6 inches from the street curb. For a fifty-five-foot street this allows about three feet clearance between all vehicles passing in the center of the street.

The upper left-hand corner of the drawing shows how passengers may alight from cars without being molested by automobile traffic. It is a common occurrence for elderly people, under the present system, to be entirely unable to mount the street cars on account of congestion of automobiles in front of the steps of the street cars.

The drawing also shows the adaptability of the loop system of street car tracks to the downtown district. Note the arrangement of using only one track on the very narrow streets, for example, Sixth street. The narrow streets are used for looping purposes only. Any car, in coming into the downtown district, can have three sides of the loop in the less congested or outlying district and one side of the loop in the congested district.

It is not the purpose of this discussion to impose upon any corporation the expense of tearing up and rearranging all of its trackage. The object is to have a municipality keep in mind a more modern arrangement of street car tracks, have these tracks designed according to well-defined lines; then, when repairs are necessary, change from the old to the new system.

[Mr. Welch has not mentioned one point in his drawing which will be of interest in cities where the gage of the city car lines does not conform to the gage of the suburban or interurban lines. It will be noted that the tracks on Seventh street are laid with a third rail just outside the outer rail of the city line so that both broad and narrow-gage cars, as he terms them, can be run on that street. A little more space between tracks is required on this street than on the other streets on this account.—EDITOR.]


SIDE WALK
SEVENTH STREET
BROAD GAUGE STREET CARS
55'-0" PARKING LIMIT
AUTOMOBILES
SIDE WALK
SPRING STREET
SIDE WALK
SIDE WALK
BROADWAY
SIXTH STREET
PROPOSED ARRANGEMENT of STREET CAR TRACKS
TO FACILITATE TRAFFIC
IN DOWN TOWN DISTRICT
S
W
N

March, 1914

# HIGH PRESSURE GAS FOR STREET LIGHTING

**By T. Singtон, Manchester, England.**

*The development of high-pressure gas has been more extensive in England than in this country, where the competition with electricity has not been developed so strongly. With the cheapening of gas and the exploitation of incandescent burners is coming the use of higher pressures in gas mains and successful competition with electricity for street lighting. This paper suggests some of the reasons why still greater development may be expected in this direction.*

High pressure gas illumination for important streets has been extremely successful in London, Paris, Berlin and large principal towns such as Birmingham; in several cases the installations have been less successful; it may therefore be interesting to draw attention to only partial success, in order that the system wherever introduced may always give the best results possible.

All the practical advantages claimed for electrical lighting, such as simplicity of switching operations, possibility of dispensing with lamp lighters, great economy of cost and so on, are actually obtained by the use of gas high pressure installations.

Complaint of extensive and highly dangerous leakage of high pressure gas is only made possible by neglect on the part of main-layers and is easily avoidable. All mains after being laid must be made subject to severe tests and any subsidence prevented by bedding the mains where necessary on a foundation of concrete.

No detrimental effect is caused by foggy or heavily smoke-laden atmosphere on the gas mantles, resulting in any diminution of candlepower. Ordinary foggy weather does not effect them at all, also not the ordinary smoke of a manufacturing district. During extraordinarily bad weather street lamps may be burning both day and night, thus eliminating any remote possibility of smoke settling on the mantles. It is also important to note that the rays of gas lamps penetrate fog considerably better than those of electric lamps.

The great objection to electric street lighting is the intense glare of the arc lamps, which electrical experts are anxious to reduce, as it tells against their system. In this respect gas lamps are superior for the eyes, because the source of light is immensely larger than the arc of the electric lamp. There is still ample scope for both gas and electrical light engineers to experiment with the object of improving the distribution of light. Such experiments if they resulted in nothing else, would also probably lead to improvements tending to lengthen the effective life of the gas mantles, which are at present insufficiently protected from the weather. Some experts assert that all sources of light should be screened down so that their intrinsic brilliancy does not exceed that of the sky, which has been estimated at about 3 candlepower per square inch.

The measurement of light and illumination has now become a science, the degree of accuracy of which is only limited by the personal error of the observers using the photometric instruments. Street photometry can measure within an accuracy of 5 per cent. of the direct candle-power measurements and within 7 per cent. of the horizontal illumination measurements. To measure the illuminating effect of high pressure gas lamps a portable photometer may be used for rough

measurements, fitted with a Bunsen screen; also the type known in Europe as the Universal photometer, the accuracy of which is very high, as the flicker attachment is used for direct measurements, thus reducing to a minimum any error due to variation in color of light source. The artificial illumination of streets being carried out by means of light sources fixed at intervals along a street, results in a varying degree of illumination, depending on the distance from the light sources, and as that illumination is proportionate not to the distance only, but to the square of the distance, and the angle at which the light falls on the surface, it will readily be seen that much depends not only on the candlepower of the lamps, but even more on the way they are spaced along the street and the height at which they are erected. With the object of bringing all the factors, namely candlepower, distance and height, into a common factor for comparison, it is becoming the practice to compare the illumination of streets by ascertaining the minimum horizontal illumination at any part of the street on a screen 3 feet above the ground level. This minimum factor is considered the important one, as it embodies all others; also because, if the minimum illumination is sufficient for the pedestrian and road traffic, the illumination thruout the remainder of the street must be sufficient.

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¶ TESTS OF HIGH-PRESSURE GAS ILLUMINATION *of streets show high results in service and in efficiency.*

In order to test high pressure gas illumination of streets satisfactorily, a series of tests should be made extending over a period of several weeks, including photometric measurements of candle-power and illumination, which should be carried out every consecutive night, weather permitting. Periodic measurements of the gas consumption and gas pressure should be made, to check those recorded by the gas meters and recorders installed. Whilst tests are being made the lamps in the street under examination must be operated precisely in the manner usual in ordinary practice; adjustments and alterations being only permitted when found to be absolutely necessary.

The following details of actual tests, made on high pressure gas street lamps, will give point to what has been stated above. The lights tested are known as the Keith high pressure gas lanterns, each containing three inverted high pressure mantles supplied with gas raised to a pressure of 55 to 60 inches of water by means of a compressor plant placed in an adjoining street, the pumps of which were driven by electric motors.

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¶ METHODS OF PLACING LAMPS *may be similar to those used for electric lights and they may be even lowered for trimming.*

The lamps were suspended from span wires. A tower ladder was used to adjust, trim and clean the lamps. Lowering gear could alternatively be used. The central hanging of light sources has many advantages to recommend it, where powerful light units are necessary, as in very busy thorofares. The most important are that the lamps can be erected at a considerable height, so that they do not come into the line of vision of either pedestrians or drivers of vehicles using the street; furthermore the lighting of the footpaths is much more even than when the light sources are carried on poles erected at the edges of the footways. A further advantage is that poles being needed for supporting the span wires, the footway is freer from obstacles to the traffic. The only serious disadvantage is the inaccessibility of the lamps. In the case of high pressure gas lamps, the lowering gear may cause trouble with the joints. It has therefore been suggested that the lamps could be supported from brackets attached to the buildings.

The average height of the lamps tested was 26 feet 6 inches and the average distance apart 107 feet; that would mean forty-nine lamps to the mile of street. Most of the photometric measurements were made at the following angles: For the maximum illumination from the rays 45 degrees from the horizontal and for the

minimum 20 to 25 degrees from the horizontal. Very numerous measurements extending over several weeks gave the following results: Average candlepower at 20 to 25 degrees from the horizontal, 1,750; average at 45 degrees from the horizontal, 1,670. Average minimum horizontal illumination derived therefrom on the pavement 0.39 foot-candles; the average maximum horizontal illumination on the pavement, 1.9 foot-candles.

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¶ ITEMS OF COST *of English installations will be some guide in the estimation of cost of work in this country.*

The costs excluding capital charges on lamps and special mains were made up as follows: Of the cost of low pressure gas delivered to the compressor plus the cost of compressing; the cost of mantles and renewable parts; labor charges of lighting, extinguishing and renewing parts. The cost of the low pressure gas delivered at the compressor slots amounted to 25 cents per 1,000 cubic feet; to which has to be added the cost of compressing, 4 cents per 1,000 cubic feet, making a total cost of 29 cents per 1,000 cubic feet delivered into the high pressure mains. Careful consumption tests showed that the consumption per mantle was 26.5 cubic feet per hour, equal to 79.5 cubic feet per hour for each lamp, giving a cost per hour for high pressure gas of 2.294 cents per hour. To this must be added the cost of mantles, globes and labor, making the total 3 cents per hour. The capital cost of plant and apparatus, including lamps, lanterns, poles, suspension and all accessories amounted to $240.00 per lantern apart from cost of the high pressure gas mains and compressor plant. The capital cost per mile of street would therefore amount to $11,760.00. During the time the tests were being made the maximum variations of any one gas lamp were from 2,058 candlepower to 686 candlepower and for all the gas lamps tested from 2,475 candlepower to 686 candlepower. It was stated above that the gas lamps cost 3 cents per hour, equal to $60.00 per lamp per annum of 2,000 hours. That would amount to a cost of $3,240.00 per mile of street. The capital costs per mile of street would amount to $12,177.60.

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¶ HEIGHTS OF LAMPS, *number of burners, cost of compression of gas, are items of great importance in estimating the results to be expected.*

High pressure gas lamps used for street lighting, have on occasion been found not to give the full results expected, thru not being properly installed or adjusted. It is of extreme importance that the correct height should be ascertained. The height given above, 26 feet 6 inches, is too great to yield the best results; it only gave 27 candles per cubic foot of gas. When placed at a more suitable height the efficiency should be at least 50 candles. Lamps placed at a height of 20 feet with only two burners, adjusted to a proper efficiency, would give a light equal to, if not better, than the three-burner lamps discussed above. The life of a mantle was found to be 400 hours, therefore, each three burner lamp would require 15 mantles per annum of 2,000 hours. The capital outlay has been found to be as follows: Per lamp, $58.00; for installing same, wages, poles, suspension gear and other smaller items, $180.00. To obtain the lowest working costs it is necessary that the compressor should be worked to its full capacity. The cost given above for compression is too high because the compressor was not worked to its full load. The flexible connection to a high pressure gas lamp requires careful watching. It may be faulty and occasion loss of either pressure or gas.

# AGGREGATE FOR CONCRETE ROADS

*At the conference on Concrete Road Construction one of the committees made a report on the aggregates to be used in the concrete. Mr. Sanford E. Thompson, the chairman of the committee, is one of the foremost experts in the theory and practice of concrete construction because he is expert in both. He shows in the report given herewith what are the reasons for failures in concrete road construction and what are the limitations of the materials and methods of construction which have been used thus far.*

THE successful development of the concrete pavement depends upon: (1) Materials, and (2) Workmanship.

It is not so much a question as to whether concrete is a suitable material for roads in comparison with other paving materials, as it is a comparison between concrete and concrete. The durability depends upon the character of the concrete.

Suppose we were to build a brick pavement. Assume that we start with a poor foundation; we lay the brick at unequal distances apart; we half fill the joints; and for the brick we use a soft, light brick. Will the pavement stand? Suppose all the workmanship is satisfactory and the brick alone is poor, shall we expect the pavement to be durable? Certainly we cannot condemn brick pavements in general because such a pavement as this does not last.

But is not this exactly what many people may expect of a concrete pavement? They lay on a poor foundation, improperly mix and place the concrete, and use materials that will not make concrete good for any purpose. They may, in fact, properly prepare the foundation, mix the materials thoroly and in correct proportions, but provide sand that is fine and stone that is soft, and then they condemn not this pavement in particular but concrete pavements in general.

It must be remembered, however, that the general public has a perfect right to condemn concrete pavements in general if a large number of concrete pavements are poorly built or are built of poor materials.

Letters from a large number of cities having concrete roads show general satisfaction with this type of pavement. Adverse criticism usually comes from cities where the specifications and descriptions of work indicate either poor materials and incorrect proportions or improper methods of construction.

Simple rules covering the most essential requirements for aggregates are as follows:

1. For fine aggregate, use only sand or other fine aggregate that has been actually tested for mechanical analysis and tensile strength of mortar, and is free from fine particles.

2. Use coarse grained sands or hard stone screenings with dust removed.

3. Use sand or other fine aggregate that is absolutely clean.

4. For coarse aggregate, use hard stone, such as granite, trap, gravel, or hard limestone.

5. If bank gravel or crushed stone is used, always separate the sand or screenings and re-mix in the proper proportions.

If local conditions prevent following any one of these rules, adopt some other material than concrete for your pavement.

Briefly taking up each one of these points:

1. Actual laboratory tests are necessary for fine aggregates, because it is impossible for the most expert builder to al-

ways distinguish by appearance between good and poor sands. Sand may be coarse, of good color, well graded, and apparently perfectly clean, and yet because of a minute quantity of vegetable matter may show practically no strength when made into mortar or concrete. Case after case has been found where good looking sand had to be rejected on laboratory test or, if used, produced defective concrete.

Note that two tests are given in the specifications—for fineness and for tensile strength of mortar.

2 Coarse sand is necessary not only for strength and density, but to prevent the formation, on or near the surface, of a layer of fine material, consisting of a mixture of dust and cement which has no durability. Mortar made with fine sand or sand having a large proportion of fine grains of silt, hardens slowly and is especially objectionable in cold weather. This prevents it attaining proper strength before the road is thrown open to traffic. A sand having a considerable proportion of fine particles may possibly show high briquet tests, and yet the mortar not have good resistance to attrition or wear.

As indicating the necessity for coarse sand, even when the mortar made from it is high in strength, various cases might be cited; one, for example, in Wisconsin, where the sand mixed into mortar showed high tensile strength, and yet, because of 10 per cent. of silt in the sand, the surface of the road was entirely unsatisfactory, and had to be covered with a bituminous wearing surface after less than a year's service. A natural sand of limestone composition frequently shows high strength in mortar, but may be poorly adapted to pavements because of an excess of fine grains.

3. Sand must be absolutely free from vegetable or organic matter, or it is liable to harden not at all or too slowly to be serviceable. Frequently, sand may be entirely satisfactory in appearance, and yet be worthless for concrete. Defective sand of this type is apt to be taken from too near the surface of the ground, so that it contains a very small percentage of vegetable loam. At least 2 feet of top soil and loam should be removed before using the sand, and in many cases it is necessary to take off as much as 4 or 5 feet, while occasionally no acceptable sand can be found in the entire bank because of the penetration to a great depth of the deleterious vegetable material.

In one case, in Wisconsin, the materials were distributed along the entire length of the road that was being improved. The laying of the concrete was discontinued before the road was completed, and for several months traffic drove over the sand

GRAVEL AND WASHED SAND *aggregates deposited on the grade for feeding the concrete mixer shown in the background, on the Ellerton grade, near Bloomfield, Ind. Photographed by Engineer of Universal Portland Cement Company.*

CONSTRUCTING CONCRETE ROADWAY *in Miami County, Ohio, with mixed sizes of gravel and washed sand. Sprinkling roadbed and materials prior to mixing and placing. Photographed by Trussed Concrete Steel Company.*

and gravel that was later used in the construction of the concrete pavement. The portion first built was good, while the other part was very defective. The cause of the difference, evidently, was due to the dirt and manure that had become mixed with the aggregates.

4 A coarse aggregate of hard quality is necessary to resist the wear and abrasion of hoofs and wheels. Failures of concrete roads have been caused simply by the softness of the coarse aggregate. In one instance, for example, shells were used for the aggregate, and the road went to pieces as soon as it was subjected to wear.

All stone, like shale, slate, shells, and soft limestone, must be rejected; while trap, granite, and conglomerate, are especially suitable materials. A hard limestone, such as that occurring in certain localities along the Hudson river, which is sold in New York as trap rock, is satisfactory for concrete roads. A hard limestone cannot be cut with a knife and the specific gravity is high, say, over 2.70.

Gravel does not bond quite so strongly with cement as does broken stone. When properly screened and free from dirt, however, and remixed with sand in the proper proportions, a good surface can be made even for a one-course pavement.

5. Many roads that are now being built will prove worthless because of the use of sand taken directly from the bank without screening. If the gravel contains as much as 40 per cent. of stones and very rich proportions are used, say one part cement to 3½ parts bank gravel, a fair concrete can sometimes be produced, but it is always cheaper in such cases to screen the gravel and remix the sand and stone in proper proportions. There will be, for example, a saving of ¼ barrel, or 1 bag, of cement per cubic yard of concrete by using proportions one part cement to 2 parts sand to 3 parts screened gravel, instead of using the unscreened bank gravel in proportions 1:3½. This difference will more than pay for the additional cost of screening the sand and rejecting part of it. At the same time, the result will be more uniform and the surface more durable because of the stones which take the wear. When an excess of sand is used in the mixture, as is the case with run-of-the-bank gravel, the mortar rises to the top when the concrete is placed and the wearing surface is less resistant than a mix that is uniform thruout.

If the rules given above are followed, and at the same time proper foundations, proportions, and workmanship are obtained, the concrete pavement will prove

durable and will resist ordinary traffic.

Tentative specifications for aggregates are presented as follows:

FINE AGGREGATES.

*Quality*—Fine aggregate shall consist of sand or screenings from hard, durable gravel, granite, trap, or other hard rock. It shall be clean, coarse, hard, free from dust, loam, vegetable, or other deleterious matter. Fine aggregate containing frost or lumps of frozen materials shall not be used.

*Samples for Test*—Average samples of fine aggregate weighing not less than 10 pounds shall be taken from the bank or pile and tested, before the acceptance of the material, for fineness and for tensile strength in mortar. Individual average samples shall be taken from each bank to be used, and new samples taken in case of a change in the character of any one bank.

Receptacles for shipment to laboratory shall be such as to retain the natural moisture in the sand.

*Fineness*—The size of the fine aggregate shall be such that the grains pass when dry a screen having ¼-inch openings. In the field a ⅜-inch mesh or, in some cases, a ½-inch mesh screen may be used for this separation.

Not more than 10 per cent. of the grains below the ¼-inch size shall pass a sieve having 50 meshes to the linear inch, and not more than 2 per cent. shall pass a screen having 100 meshes to the linear inch.

*Tensile Strength of Mortar*—Mortars composed of one part Portland cement and 3 parts fine aggregate, by weight, when made into briquets shall show a tensile strength at least equal to the strength of 1:3 mortar of the same consistency, made at the same time, and with the same cement and standard Ottawa sand. The sand shall not be dried before being made into briquets, since this sometimes improves its quality, but correction shall be made for moisture when weighing the materials.

Tensile tests may be made at ages of 72 hours, 7 days, and 28 days. At early periods the strength need not attain the full ratio of 100 per cent. to standard sand mortar, provided this is attained at a later period. In no case, however, shall sand be accepted for pavement work whose strength in 1:3 mortar at the age of 72 hours is not at least 80 per cent. of the strength of the standard sand mortar.

*Screening*—If bank gravel or crushed stone is used, it must be screened and remixed in the proper proportions.

If the sand does not fulfill the above requirements for fineness, it shall be washed or else screened when dry over a 10-mesh screen placed at such an angle as to remove the particles finer than a No. 50 sieve.

*Washing*—Fine particles may be removed by washing with a large volume of water in a box provided in the bottom with perforated pipes and arranged for the silt and water to flow off thru a trough from the top of the box and the sand to be drawn out from below.

COARSE AGGREGATE.

*Quality*—The coarse aggregate shall consist of clean, hard, durable, granite, trap, conglomerate, gravel, or other hard rock, free from dust, loam, vegetable or other deleterious matter. In no case shall coarse aggregate be used which contains frost or lumps of frozen material.

Coarse aggregate containing soft particles shall be rejected.

Coarse aggregate shall not contain a large proportion of flat or elongated particles.

*Fineness*—For one-course pavements, the size of the coarse aggregate shall be such as to pass an inclined or rotary screen having 1½-inch circular openings and be retained on a similar screen having ⅜-inch openings.

For 2-course pavements the size of the coarse aggregate for the bottom course shall be such as to pass an inclined or rotary screen having 2-inch openings and be retained on a similar screen having ¼-inch openings. (This assumes a perfect bond between the first and second courses.)

NATURAL MIXED AGGREGATES.

Natural mixed aggregates shall not be used as they come from the bank or crusher, but shall be screened and remixed in the proper proportions.

# THE MAINTENANCE OF CONCRETE ROADS

## METHODS AND COST OF REPAIR

*The Committee on Methods and Cost of Repairing and Maintaining Concrete Roads, appointed to report to the Chicago Conference on Concrete Road Building, was composed of three members, each of whom made his own report.*

**By EDWARD N. HINES, Chairman,**
**Detroit, Mich.**

*The first is by Edward N. Hines, chairman of the Board of County Commissioners of Wayne County, Michigan, which is responsible for the greatest development of concrete road construction which has yet been made. He is quite frank in his statement of the work that has been necessary, but unfortunately is not able to give the whole cost of the repair and reconstruction which has been necessary because the pavements so treated were still under the contractors' guarantees and were repaired without expense to the county.*

IN preparing and presenting a report on Methods and Costs of Repairing and Maintaining Concrete Roads, we assume that it has to deal with the metaled surface rather than the shoulders, ditches or sides, and with this end in view we are presenting the individual experience of the members of your committee to whom this subject has been assigned.

With the opportunity to make a field study, having partly in charge at least the many miles of concrete roads in Wayne county, some of which are now in their fifth year of service, it seems to me that the actual experience and methods followed are of more value than any laboratory experiment or theoretical discussion. We, in Wayne county, have followed two methods in maintaining the concrete roads, the first of which consists in filling the open expansion joint on the roads first built before the development and use of the armor joint, and in the filling with a mastic such longitudinal and transverse cracks as have developed.

A crew consisting of seven men and a team, provided with a tar kettle, is utilized for the work. The foreman is paid $5 a day, the team and driver $5 a day, the "tar man" $3 a day, two laborers at $2.50 each and two laborers at $2.25 each. The tools used consist of two wire bristle brooms, a wheelbarrow, a couple of shovels and a tar bucket with a round spout. Tarvia X is now used exclusively. A lighter grade was first tried out, but did not give such permanent results as the heavier grade. Two men are utilized to sweep all cracks clean with the wire brooms, after which the man with the tar kettle fills the cracks with the tar which is heated to about 225 degrees Fahrenheit. An excess of tar is poured in so that it extends an inch or so beyond the edge of the crack. It is then allowed to stand in the crack for a few minutes to prevent it from "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffc to iron out. The excess

tar and sand is worn away rapidly leaving a smooth, even surface, over which

George F. Key, to the Board of County Road Commissioners:

| | | | | | |
|---|---|---|---|---|---|
| Michigan Ave. Road | Tar | 20 bbl. at | $6.00 | $120.00 | |
| 17 miles | Labor | 10 da. at | 22.50 | 225.00 | |
| | Sand | 18 yds. at | 2.00 | 36.00 | $381.00 |
| Grand River Road | Tar | 14 bbl. at | 6.00 | 84.00 | |
| 10 miles | Labor | 6 da. at | 22.50 | 135.00 | |
| | Sand | 8 yd. at | 2.00 | 16.00 | 235.00 |
| Gratiot Road | Tar | 3 bbl. at | 6.00 | 18.00 | |
| 1½ miles | Labor | 2 da. at | 22.50 | 45.00 | |
| | Sand | 4 yd. at | 2.00 | 8.00 | 71.00 |
| Jefferson Road | Tar | 6 bbl. at | 6.00 | 36.00 | |
| 1¾ miles | Labor | 2 da. at | 22.50 | 45.00 | |
| | Sand | 4 yds. at | 2.00 | 8.00 | 89.00 |
| Van Dyke Road | Tar | 5 bbl. at | 6.00 | 30.00 | |
| 2 1/3 miles | Labor | 1½ da. at | 22.50 | 33.75 | |
| | Sand | 4 yd. at | 2.00 | 8.00 | 83.00 |
| Mt. Elliott Road | Tar | 3 bbl. at | 6.00 | 18.00 | |
| 1½ miles | Labor | 1½ day at | 22.50 | 33.75 | |
| | Sand | 4½ yd. at | 2.00 | 9.00 | 60.75 |
| River Road | Tar | 10 bbl. at | 6.00 | 60.00 | |
| 7 miles | Labor | 5 da. at | 22.50 | 112.50 | |
| | Sand | 12 yd. at | 2.00 | 24.00 | 196.50 |
| Eureka Road | Tar | 4 bbl. at | 6.00 | 24.00 | |
| 4¼ miles | Labor | 2 da. at | 22.50 | 45.00 | |
| | Sand | 4 yd. at | 2.00 | 8.00 | 77.00 |
| Wayne Road South | Tar | 1 bbl. at | 6.00 | 6.00 | |
| ½ mile | Labor | ½ da. at | 22.50 | 11.25 | |
| | Sand | 1½ da. | 2.00 | 3.00 | 20.25 |
| Woodward Ave. Road | Tar | 5 bbl. at | 6.00 | 30.00 | |
| 2¼ miles | Labor | 2 da. at | 22.50 | 45.00 | |
| | Sand | 6 yd. at | 2.00 | 12.00 | 87.00 |
| 51 miles | Total | | | | $1,300.50 |

no jolt is apparent in passing either with a horse drawn or motor driven vehicle. This method of repair prevents the edges of the concrete from spalling and chipping, and no water can get thru to the subgrade to freeze and heave in cold weather.

The work is preferably done on hot, dry days. It has been suggested to us that the better time to handle this work would be in the late fall when the cracks would be open the widest due to contraction, but the results we have secured in the summer months have been so satisfactory that we have not tried out the latter plan. The small pit holes which are due simply to some foreign substance getting into the concrete like clay, wood or some fragment of inferior rock which might chance to be a part of the aggregate, are treated in the same manner. As to the cost of this method, I desire to present a verbatim report of the engineering staff, Messrs. George A. Dingman and

A percentage was added to cover engineers, inspectors and the depreciation of machinery and building and other "overhead" charges, totaling approximately $1,450. (See page 39, Seventh Annual Report.) This report covers the fiscal year of the Board from October 1, 1912, to September 30, 1913, inclusive. The greater part of this mileage was treated for the first time. Once a year is often enough to go over the work and touch it up here and there, as we have found by experience that the bulk of the repairs previously made is intact.

We have not had as good success in treating the entire surface of a road where the concrete from any cause has not stood the wear. One-half mile of concrete on Fort road, built by Porath & Son, about 800 feet on Grand River road, built by the Owosso Construction Company, and one and three-quarters of a mile on Gratiot road, out of the 80 odd miles of concrete road in Wayne county,

are not up to the standard of the balance of the construction, and they have been surfaced with Dolarway, a special grade of Tarvia and Tarvia X. The surfaces of Fort and Gratiot roads were both rough, having been built in cold weather, and opened for traffic before the concrete had thoroly hardened. Fort road was surfaced by the contractor before the board would accept the road and make the final payment. It carries a fairly heavy mixed traffic, not as great, however, as either Grand River or Gratiot roads. A special grade of Tarvia was used, furnished by the Barrett Manufacturing Co. The road was first swept by a street sweeper which was followed by men with wire brooms. About one-half gallon of bitumen to the square yard was used, and the whole covered with coarse sand and rolled with a ten-ton roller. This repair was made early in the summer and was not touched in any manner for a period of two years. By this time it had scaled off in spots quite badly, and was gone over again in the summer of 1913, using Tarvia X and a washed roofing gravel about one-quarter of an inch in size. We have no record of what the first cost was to the contractor, as we paid nothing for it.

Gratiot road was surfaced at no cost to us by the Dolarway people in the spring of 1912. By the summer of 1913 about half of the original coating had scaled off, at which time we patched it up, using a special grade of Tarvia and Tarvia X. The Tarvia X has given the better result to date. Washed roofing gravel was used with the bitumen. This work was also rolled with a ten-ton roller. Gratiot road carries an average traffic of over 1,000 vehicles a day. (On the last count made one week in August and one week in September the average traffic per day was 1,210, of which 36 per cent. was motor traffic and 64 per cent. horse drawn vehicles.) The surface of the road is wavy, and we have found it necessary to go over the work two or three times during the summer, touching up small spots here and there where it had scaled off. The cost of the work done by our board is in the neighborhood of 9 cents a square yard.

**By J. S. McCULLOUGH, City Engineer,**
**Fond du Lac, Wis.**

*The second member of the committee, J. S. McCullough, is city engineer of Fond du Lac, Wis., and has been the engineer for some excellent concrete paving work. The streets are still in the hands of the contractors, however, and his report is restricted to statements of methods of filling cracks and repairing cuts in pavements for trenches of public utilities and plumbers.*

The repairs on our pavements to the present time have been taken care of entirely by contractors who built the pavements, and are part of their obligation, under our contract. The pavements are guaranteed for 5 years, and our oldest work was 5 years old this past summer.

The method of repairing cracks is similar to that in use in Wayne county. Both asphalt and Tarvia have been used, but we find Tarvia gives the better results.

We have had some work of replacing pavement cut out for installing service pipes, such as sewers, gas, and water, also a long piece for installation of telephone conduit. The telephone work was done by contract by the telephone company; all other repair of such excavations has been done by the city thru its repair gang.

The excavation is made by the public utility after receiving permit from the Board of Public Works. Excavation is required to be back filled with gravel, sand, or crushed stone to subgrade of pavement. Our men then proceed to trim the edges of hole so walls of cut are as near perpendicular as possible, and is washed with a grout of cement and water.

Mixture same as original pavement is then put in and finished same as original work. Traffic is kept off until concrete is hard. Where the work has been carefully done we have had good success in making such patches. The cost will not exceed that of replacing brick that are cement grouted and, in fact, what records we have would indicate that concrete pavement patches can be replaced cheaper than the brick.

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**By F. P. WILSON, City Engineer,**
**Mason City, Iowa.**

*The third member of the committee is F. P. Wilson, city engineer of Mason City, Iowa, one of the earliest of the modern users of concrete paving. His rules for the construction of concrete streets are thoroly practical and he points to the results of his work as proof of the necessity of following them.*

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Mr. Hines' experience as given in his paper on the topic, "Methods and Costs of Repairing and Maintaining Concrete Roads," I have carefully read, and the contents of the same describe methods I have used on the maintenance of cement city streets and I consider them most practicable and economical methods for maintaining a concrete road or pavement. If the roadway or pavement is given a careful inspection at least twice a year and all the defects filled with Tarvia X and coarse, clean sand, free from loam or clay, put on the road or street when the same is perfectly dry, clean and free from any foreign substance, when the temperature of the weather is at least 80 to 90 degrees Fahrenheit, good results will follow and the concrete road or pavement will last indefinitely and the cost of maintenance will be reduced to a minimum.

It has been my experience as an engineer during the past 6 years in the design and construction of approximately 300,000 square yards of cement paving for city streets that to reduce the cost of repair and maintenance to a minimum, the following rules should be carefully carried out in the construction of cement streets or roads:

1. To have the subgrade thoroly drained, where it is necessary, by using farm drain tile not less than 4 inches in diameter, after which the subgrade should be rolled and compacted with a heavy steam roller until it is perfectly solid over its entire surface.

2. After the subgrade has been prepared, great care should be taken to keep it wet, before placing the concrete, as a dry subgrade draws the moisture from the concrete mixture and is thus harmful.

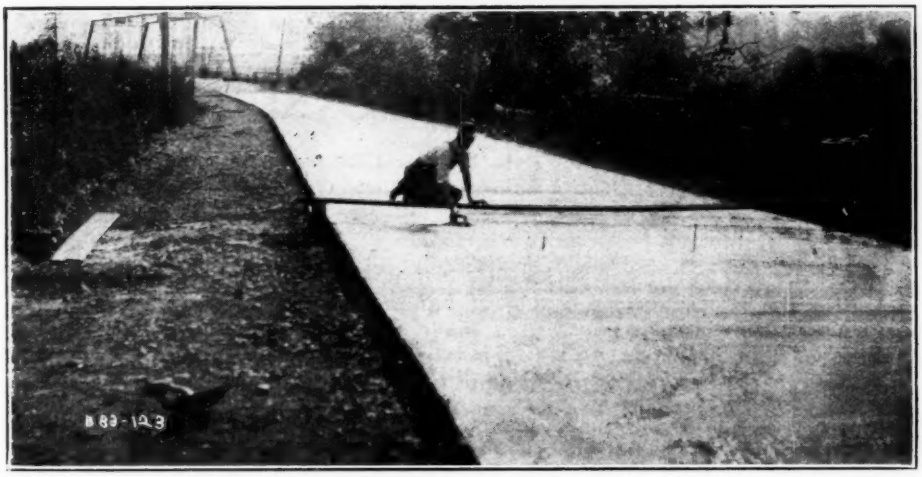
3. Have a first class Portland cement that will stand the tests required by the American Society of Civil Engineers.

4. Have a sharp, clean sand, which does not contain more than 2 per cent. of loam.

5. Have a good hard stone or gravel, free from dust, loam or clay and crushed so that it runs from ¼ inch to 1½ inches in size, 66 per cent. of the stone to be the coarser and 34 per cent. the finer of the stone aggregates.

6. The fine aggregates and coarse aggregates should be thoroly mixed with an up-to-date batch mixer, until all the stone is coated and is of such consistency that all that is required is to level off the mass so that the concrete runs into place, no tamping being required and a dense compact volume is obtained.

7. Have an expansion joint 1 inch in width left next to the curb on each side of the street, this space to be filled with an asphalt filler. Have transverse expansion joints ½ inch in width left every 37 feet 6 inches at right angles with the curbs, these expansion joints to be protected on either side with steel plates, 2½ inches in depth, ¼ inch in thickness, with



FINISHING THE SURFACE *of a concrete pavement in Miami County, Ohio, with wooden float. Gravel shoulders will be placed along the side, Trussed Concrete Steel Company's joint protection.*

a shear member 6 inches in length cut out of the sides of the plates at equal distances and bent at right angles and extending into the concrete, these steel plates to be not less than 15 feet in length. Between these plates place a three-ply tar felt paper especially prepared for the expansion joint.

8. Finish the surface of pavement with a wood float, made of a coarse grained soft wood, so as to give a uniform rough surface which will give a good foothold.

9. The curing of concrete pavement is one of the most important features and on it depends the durability and strength. The pavement, immediately after it is laid, should be covered and protected from the sun, and as soon as it is hard enough, should be sprinkled daily and kept wet not less than eight days.

10. Concrete paving, where the width of roadway is more than 20 feet between curbs, should be reinforced with No. 7 American wire, to eliminate cracks or cracking.

11. A concrete pavement, after it is laid, should be protected and the traffic kept off for at least three weeks, so as to give it a chance to thoroly harden.

12. To obtain a first-class result in the construction of concrete streets, also to reduce the maintenance of the same to a low cost, every detail as heretofore described must be followed. The methods described I have followed in the good old State of Iowa and other states in the Northwest in the construction of concrete streets, and the results speak for themselves.

COVERING CONCRETE PAVEMENT *in Greene County, Indiana, to cure. Photographed by Universal Portland Cement Company.*

# Voltage Regulation in Electric Distribution System

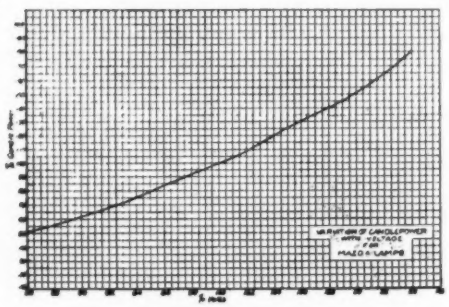
**By G. G. Post, Electrical Engineer,**
**The Milwaukee Electric Railway and Light Co., Milwaukee, Wis.**

*Mr. Post has explained in his interesting paper prepared for the Wisconsin Electrical Society a subject but little known outside the fraternity of electrical engineers in a manner which leaves little to be desired. The necessity of uniformity in current supplied to any consumer is generally recognized and the methods of securing this uniformity are here explained in sufficient detail to be clearly understood, but Mr. Post has minimized the practical difficulties in applying the methods so that the process seems easier than it really is.*

ONE of the best assets a public utility can have is satisfied consumers. One of the most important factors in satisfying the consumer, aside from reasonable rates, is good service; and, one of the most important factors in rendering good service, is good regulation. Fluctuating voltage results in variations in the intensity of light, which is sure to annoy consumers and bring complaints.

Plate No. 1 shows the relation between light impressed voltage for tungsten lamps. Roughly, 2 per cent. variation of voltage means 8 per cent. variation of light.

The Railroad Commission of Wisconsin has ruled (Rule 25) that "each electric utility operating in a city having a population of 1,500 or more shall adopt a standard voltage for the entire constant potential system and shall maintain the voltage within 3 per cent. of such standard on all lighting circuits during lighting hours; on power circuits and during other than lighting hours, the voltage shall be maintained within 10 per cent. of the standard. All other electric utilities shall maintain their voltage regulation on all constant potential circuits during lighting hours so that the maximum voltage furnished any consumer shall not be more than 6 per cent. above the maximum voltage at the consumer's cut-out."

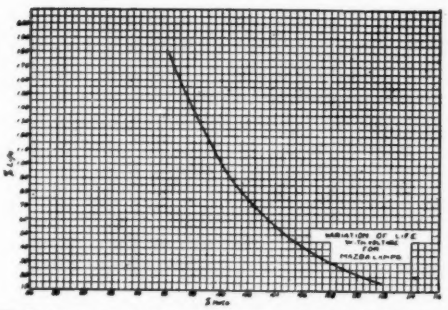


VARIATION OF CANDLE POWER, *left-hand scale, with the voltage of current, bottom scale, for Mazda lamps, is shown by this curve.*

Rapid variation of voltage well within 3 per cent. of normal will however, be extremely annoying to certain consumers, if frequently repeated; while if the fluctuation is sufficiently gradual, it will probably not be noticed.

Continued low voltage will bring complaints more surely than continued high voltage. Consumers desire light or illumination and will generally overlook the shorter life of lamps caused by high voltage, if the service in other respects is good. Some consumers, however, understand the relation between life of lamps and voltage, but they are few.

Plate No. 2 shows plainly the effect of high voltage in reducing the life of tungsten lamps and indicates that 2 per cent. increase of voltage over long periods will reduce the life 25 per cent. In other



VARIATION OF LIFE *of Mazda lamps in hours, left-hand scale, with voltage of current, bottom scale, is shown by this curve.*

words, those companies which are furnishing free renewals or renewal allowances will have their renewal expense increased 25 per cent. if they increase their voltage 2 per cent. without increasing the voltage rating of their lamps accordingly.

Close regulation in the case of power consumers is not as essential as in the case of lighting consumers, but under the conditions usually existing, it is found necessary to connect some lighting consumers to power circuits. This means in general that if the regulation is maintained sufficiently close for satisfactory lighting, there will be no cause for complaint from power consumers.

It has, therefore, been found necessary for central station companies to devote a large amount of time and study to the development of proper and sufficient methods for obtaining the regulation of voltage required in order to furnish satisfactory service.

There are two general methods in use for regulating the voltage at the consumer's cut-out:

First—Regulation of the station bus-bar or generator voltage.

Second—Regulation of the individual feeders.

Sometimes a combination of the two methods is adopted.

The regulation of the generator or bus-bar voltage is satisfactory where only one feeder supplies the distributing system or where all feeders have approximately the same voltage drop and supply loads having similar characteristics. Generator or bus-bar voltage can be regulated either by hand adjustment of the field rheostats or automatically by means of Tirrill regulators. Regulation of individual feeders is necessary in A. C. plants, where the feeders are of different lengths and supply loads of widely differing characteristics. It often happens in such cases that the bus-bar voltage can be regulated to supply good regulation on one feeder, allowing feeder regulators to regulate the remainder of the feeders. An example of this combined method exists in one of the power plants of the Milwaukee Electric Railway and Light Company, where there is a heavy power feeder which, if equipped with feeder regulators, would require an expenditure of approximately $2,500. Instead of going to this expense it has been found practical to regulate the bus-bar voltage so that the pressure on this feeder is maintained within satisfactory limits while the remainder of the feeders are taken care of by their individual regulators.

With the above general remarks the subject naturally divides itself into two divisions:

First—Regulation of D. C. systems.

Second—Regulation of A. C. systems.

In D. C. plants of 150-kw. and less, automatic regulators of the Tirrill type, operating directly on the generator fields, can be used to advantage. Such regulators introduce little added complication; and, since the load is carried over only one or two feeders, the regulator can be set to maintain close regulation at the consumer's cut-out. This is done by ascertaining from the records obtained by means of portable charts the proper voltage to be carried on bus-bars for various loads on the system.

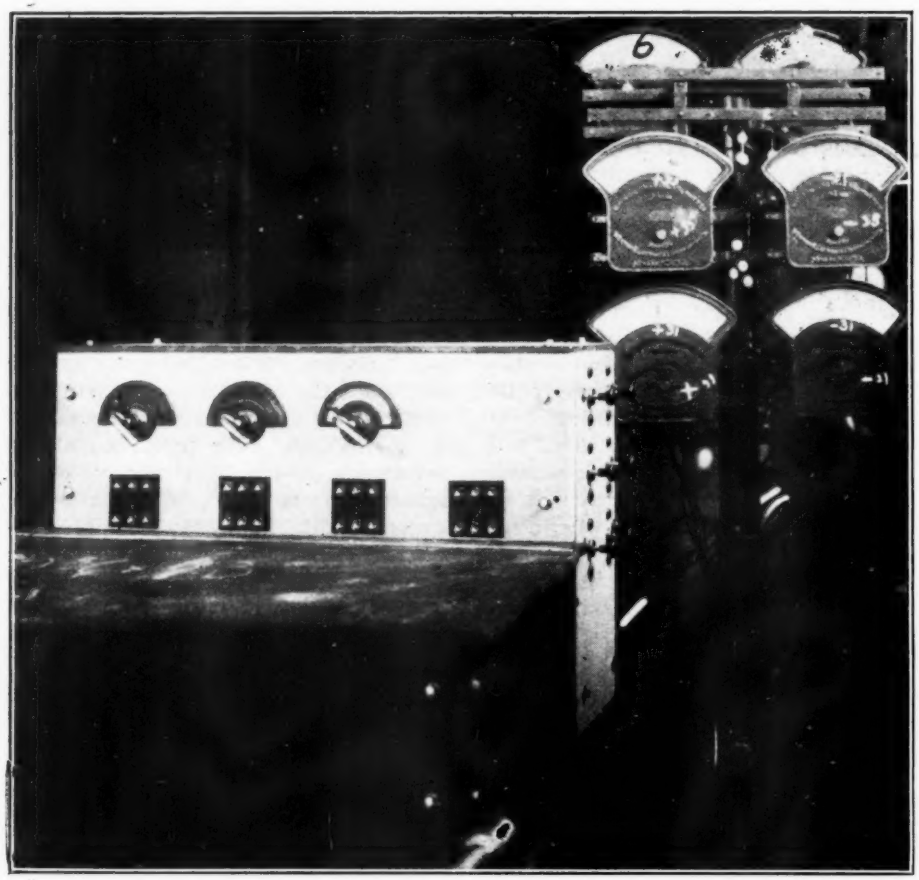
In plants of over 150-kw., Tirrill regulators can be used, but in order to use them it is necessary to provide exciters which add a complication not otherwise required. It has become the practice in large D. C. systems to regulate by hand, and this is especially true where generators must be arranged to supply two or more sets of bus-bars operating at different potentials.

Feeders having similar characteristics

as regards voltage drop and load are connected to the same bus-bars and the bus-bars are regulated accordingly. In such a system it is necessary to provide means of throwing any feeder from one set of bus-bars to the other and to carry any particular feeder on the bus-bars which will give the best voltage at the consumer's cut-out.

Different voltages on two sets of station bus-bars can be maintained by the use of boosters. In larger stations the result is attained by operating generators on each set of bus-bars absolutely independent of each other.

In order to secure the greatest degree of reliability in the service, distributing mains of D. C. systems are usually tied together in one network. It is evidently necessary to provide the station operator with some means of determining when it is necessary to transfer a feeder from the high bus to the low bus or vice versa. This is accomplished by means of pressure wires brought back from the centers of distribution of each of the feeders. If a feeder is connected to the high bus and the load goes off causing the voltage to rise at the center of distribution, the operator is made aware of the fact by the reading of the voltage obtained from the pressure wire and transfers the feeder from the high to the low bus. If the feeder is connected to the low bus and the voltage at the center of distribution decreases, due to increased load, the operator transfers the feeder from the low to the high bus.



OPERATOR'S DESK, *where line voltages are read. This is the pulse of the system and tells where regulation must be made and how much.*

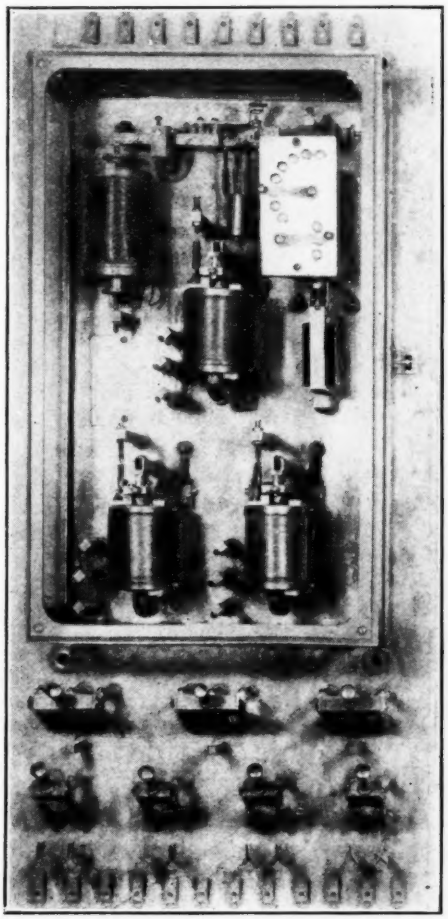
Plate No. 3 shows the operator's desk at the power station where voltage readings are taken. The regulating points are determined by the voltage setter from the indications of portable charts set at various points on the system, and those points are selected as the regulating points which give the best average results at the consumers' cut-outs.

The regulation of the small A. C. system is accomplished in the same manner as that of the small D. C. system. It is simply necessary to obtain by means of portable graphic instruments records of the voltage at various points on the system and maintain the voltage of the bus-bars at a value to give constant potential at the center of distribution which will give the best average results at the consumers' cut-outs.

In large A. C. systems, involving many feeders, the regulation is usually accomplished by means of feeder regulators connected to individual feeders.

Plate No. 4 shows a general view of a Tirrill regulator used on A. C. machines. The regulator shown operates on the exciter field short-circuiting the field rheostat when the voltage tends to drop and cutting the exciter-field rheostat into circuit again when the voltage tends to rise, thereby maintaining proper potential. By properly adjusting the instrument, the bus-bar voltage can be carried at any predetermined value within the limits of the instrument. If it be required to regulate the bus-bars for any particular feeder, the compensating winding of the regulator is connected in series with the secondary of a current transformer on the feeder to be regulated. This automatically results in increasing or decreasing the voltage on the bus-bars in accordance with the load on the feeder being regulated.

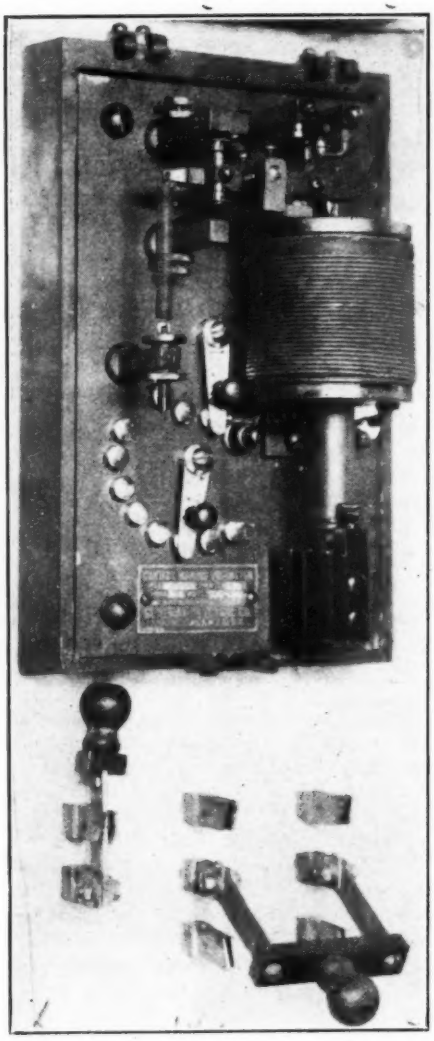
In general, the regulation of each feeder becomes a little problem in itself. The voltage setter ascertains from his voltage charts the causes of poor regulation and adjusts his station regulators accordingly or suggests changes in the distributing system to accomplish the desired results. Hand-operated feeder regulators are very little used at the present time, and most feeder regulators are automatic in their action. They are generally equipped with an operating motor which is controlled by a specially constructed relay or contact-making voltmeter.



TIRRILL AUTOMATIC REGULATOR *of voltage in bus-bars of feeder system.*

Plate No. 5 shows the contact-making voltmeter manufactured by the General Electric Company. These instruments are equipped with contacts which control the relay connected with the control circuit of the operating motor and cause the regulator to increase or decrease the feeder voltage in accordance with the load on the feeder or the voltage on the bus-bars.

There are two general types of feeder



CONTACT-MAKING VOLT METER *to control the operating motor of automatic feeder regulator.*

regulators, known as the switch type and induction type. The switch type is relatively little used on account of the excessive number of moving parts and trouble due to burning of contacts.

In the use of a three-phase, four-wire system of distribution, there is apt to be considerable drop in the neutral of the feeders if the loads on the various phases are unbalanced. This is provided for by installing a current transformer in the neutral wire of the feeder and connecting a line-drop compensator in the secondary of the current transformer in such a way that the secondary voltage of the compensator reacts on the potential coils of the contact-making voltmeters. It will be noticed that the effect will be most pronounced on the phase which is unbalanced.

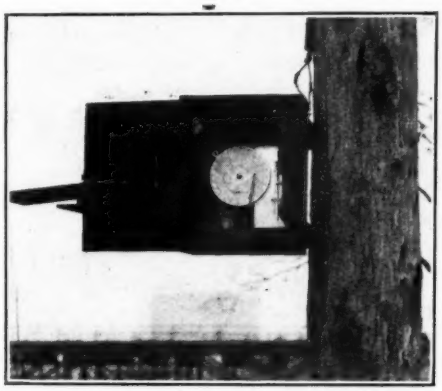
In making systematic voltage surveys, it is often found impracticable to set the portable charts on customers' premises, owing to the annoyance of repeated visits by employes of the company. It has, therefore, been found advisable to install special boxes on poles located at the approximate centers of distribution and connect them with the secondary system so that charts can be set in the boxes and observations taken without in any way interfering with consumers.

Plate No. 6 shows a general view of one of these boxes with the door open and the portable voltmeter used for checking the chart when installed and removed.

In order to illustrate the conditions encountered by the voltage setter a number of charts are given herewith, showing the voltage obtained before and after adjustments have been made or corrections applied:

Chart No. 1-A—Shows the result of over-compensation.

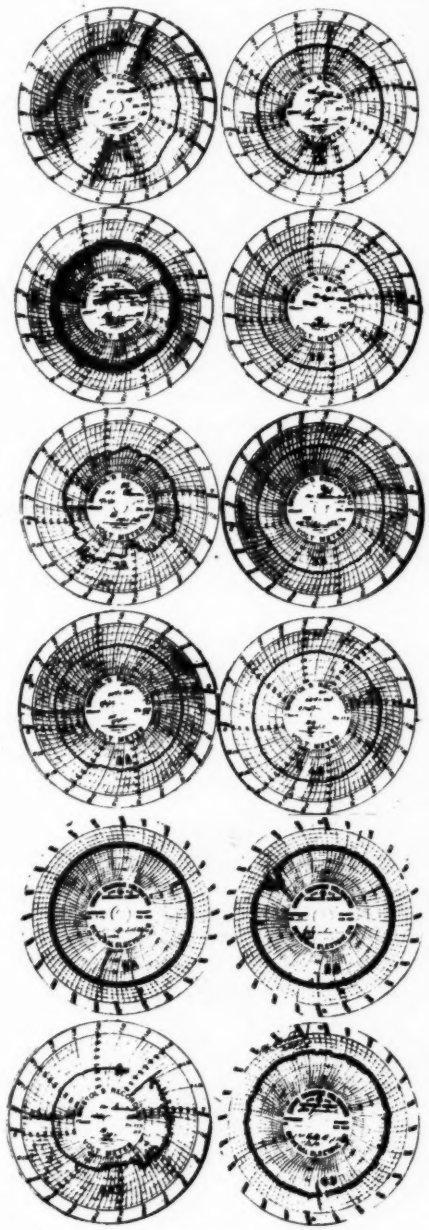
Chart No. 1-B—Shows the voltage taken in the same location, after proper adjust-



BOX SET ON POLE *to hold instruments for taking line voltage charts on consumers' lines when making voltage surveys, without entering private premises.*

ments have been made on the station regulator.

Chart No. 2-A—Shows rapid fluctuations in voltage, due to primary drop, caused by the automatic frequent starting and stopping 150-h.p. three-phase A. C. induction motor.



CHARTS SHOWING EFFECT OF REGULATION *"before and after," in order of description in next column; Nos. 1a and 1b to 6a and 6b.*

Chart No. 2-B—Shows the regulation on the feeder after the branch of the feeder supplying lighting customers had been transferred to another circuit.

Chart No. 3-A—Shows the voltage on a secondary line due to a transformer fuse being blown.

Chart No. 3-B—Shows the regulation at the same point after the fuse had been replaced.

Chart No. 4-A—Shows a slight drop over the lighting period, due to primary drop.

Chart No. 4-B—Shows the conditions at the same point after rearranging the overhead to eliminate the drop.

Chart No. 5-A—Shows the regulation in a certain location under normal operating conditions.

Chart No. 2-B—Shows the regulation on sulting from the blowing of a transformer fuse and the drop in voltage which resulted, due to feeding over four blocks of secondary line.

Chart No. 6-A—Shows voltage conditions when a secondary fuse had blown on a 25-kw. transformer in a manhole.

Chart No. 6-B—Shows the same after the fuse had been replaced.

Chart No. 7-A—Shows the voltage at a consumer's cut-out, due to feeding over about four blocks of secondary wire.

Chart No. 7-B—Is taken from the same section but close to the transformer, showing that the feeder regulators were properly set. This may be taken as an example of how the voltage setter determines whether poor voltage conditions are due to line drop or to the setting of feeder regulators.

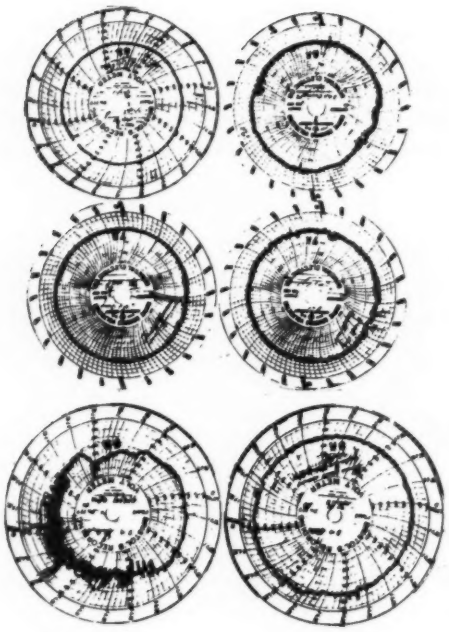
Chart No. 8-A—Shows the regulation of an under-compensated feeder.

Chart No. 8-B—Shows the same feeder after the compensation had been corrected.

Chart No. 9-B—Shows the regulation in a certain section of the D. C. district when it was being fed from a 500,000 C. M. cable.

Chart No. 9-A—Shows the regulation after the feeder had been changed to 2,000,000 C. M. capacity.

While many of the illustrations given



CHARTS *7a, 7b, 8a, 8b, 9a and 9b, taken to show effects of regulation as described in text.*

refer to a relatively large system, the principles brought out are general and will apply in all systems where standard equipment is used. The Railroad Commission of Wisconsin has ruled (Rule 26) that "each utility furnishing electric service shall provide itself with one or more indicating voltmeters, and each utility serving more than 250 consumers shall have one or more graphic recording instruments, these instruments to be of a type and capacity suited to the voltage supplied."

It has been found possible in Milwaukee and suburbs to obtain good voltage regulation by using approximately one portable graphic chart for every 750 consumers. A number of the suburbs in which the company operates, have less than 250 consumers, and even then it is found advisable and necessary to keep one chart in operation. In addition to this, graphic voltmeters should always be installed on station and substation busbars, in order to show whether the voltage conditions observed on the system are due to line conditions or not.

GOOD LIGHTING *of a Business Street.*

# PARR SHOALS POWER DEVELOPMENT

## FOR COLUMBIA, S. C.

**By George G. Shedd, Supervising Engineer, Augusta, Ga.**

*This description of the development of a water power to supply Columbia, S. C., with electric light and power is a continuation of the paper in the February Number, describing the work on Stevens Creek, Georgia, and shows the methods of carrying on the work which were used at both plants, giving many pointers of value in any large construction undertaking.*

THE Parr Shoals water power development is located about 1½ miles upstream from Peak and Alston, South Carolina, and 27½ miles above Columbia.

The drainage area at this point is estimated to be 4,570 square miles, and is in its upper part mountainous, largely covered with forests. The lower part is flatter and a considerable portion is under cultivation.

Very good records of run-off are available, particularly at Alston, from 1896 to 1907. The lowest recorded average weekly flow occurred in October, 1907, and was 1,260 cubic feet per second. The lowest average monthly flow occurred in October, 1904, and was 1,614 cubic feet per second. The greatest flood on record, occurred August 27, 1908, and from local information, was about 32.7 feet above the extreme low water mark at Alston of 1907. The discharge is estimated to have been about 222,000 cubic feet per second.

Based on past records, and a weekly load factor of 33 1/3 per cent., the delivered horsepower at Columbia will be only occasionally less than 20,000 horsepower.

The development consists principally of a dam, with a total length of about 2,740 feet, including the power house, a power house 300.5 by 51.6 feet in plan, a tailrace which is obtained simply by widening and deepening the original east river channel, a double circuit steel tower transmission line, 26 miles long, to Columbia, and a substation at Columbia.

The dam is constructed of cyclopean concrete thruout. The spillway section is of the ogee type, 2,000 feet long, with an average height of about 39 feet, and a maximum height of about 55 feet. A short section of non-overflow dam, with its crest 15 feet above the spillway is constructed between the power house and the east shore, and an earth embankment with a maximum height of 15 feet and total length of 300 feet, has been built on the west shore.

The dam contains six sluice gates adjacent to the power house, with a clear opening of 7 by 9 feet each. These have a combined capacity of about 14,400 cubic feet per second, with head-water at the crest of the dam, and tail-water at normal level. The operating devices for the sluice gates are located within the dam, and the crest of the dam is fitted with the flashboard sockets, which will later be used for 5 feet of flashboards.

The dam is designed to pass safely a flood considerably in excess of the maximum flood on record, which would have caused a depth of about 9 feet over its crest.

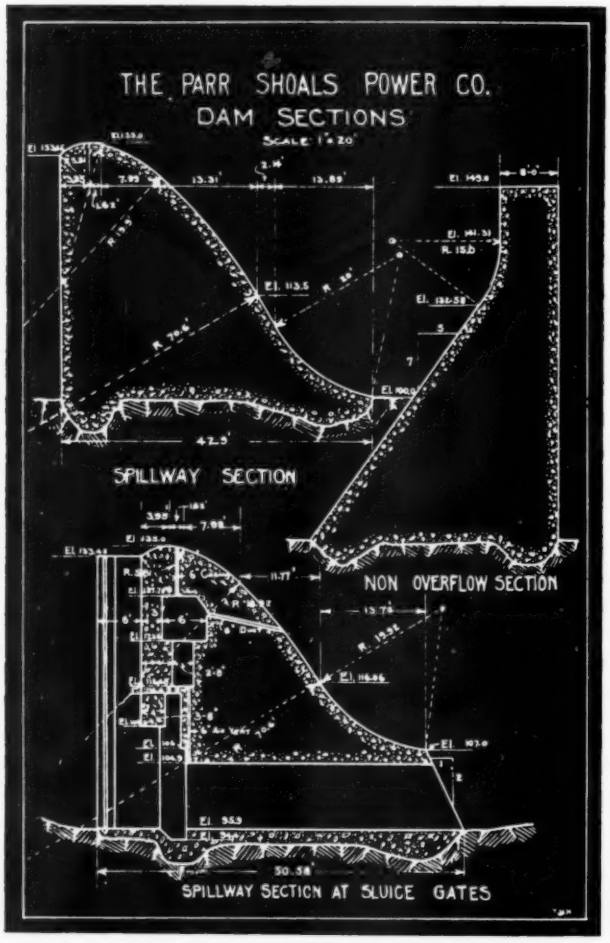
The concrete for the dam has been mixed in proportions of one part portland cement, three parts sand and six parts broken stone. In the concrete has been imbedded about 7 per cent. of plums, con-

sisting of large, sound pieces of rock, or boulders, in many cases weighing 6 or 8 tons each.

The foundation is principally of an excellent quality of granite and schist, and methods similar to those described in the February number for Stevens Creek were used in preparing the bottom.

The power house is designed for an ultimate installation of eight vertical type units of 3,100 k.v.a. each, and two vertical exciter units of 300 k.w. each.

The substructure is a combination of cyclopean and reinforced concrete masonry, and the superstructure is a steel frame, with brick walls. The roof for the main portion of the building is of hard pine, and that for the low portion, or gallery, is of concrete. Both are waterproofed with five ply tar and gravel covering.




The turbines are of vertical shaft 86-inch diameter, single runner, downward discharge type, set in reinforced concrete, scroll case flumes, and have draft tubes molded in concrete, so proportioned that the velocity is gradually decreased to 5 feet per second. The flumes are controlled with large steel gates, 14 by 25 feet, hinged at the bottom, and operated by means of a traveling hoist, running on tracks on the head wall.

Two filler gates, 4 by 7 feet each, are provided in each unit. Screen racks are also provided, supported by reinforced concrete piers, and protected at the top with a reinforced concrete curtain wall.

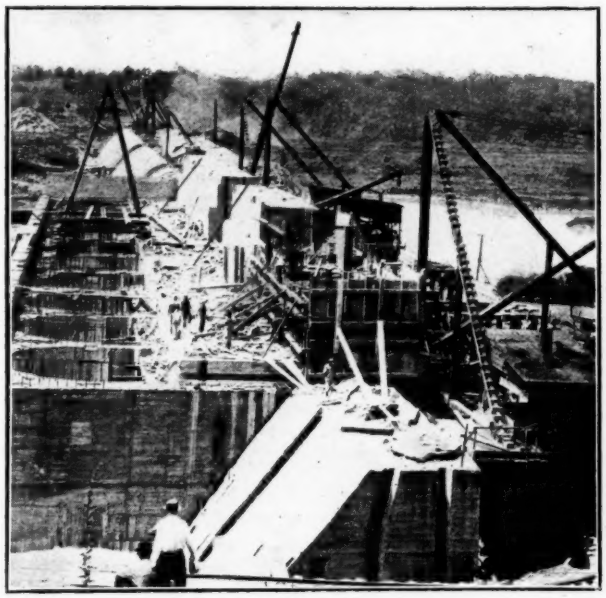
The turbines are designed to run at a speed of 100 r.p.m. and will furnish 3,600 b.h.p. at 35 feet head with an efficiency of 86 per cent.

The governors are located on the main floor, and arranged to be controlled from the switchboard, altho hand control is also provided. They are of the oil pressure double floating lever type, with a central oil pumping and pressure system, operating normally at 165 pounds pressure. They are designed to control the speed within very narrow limits, and eliminate entirely any hunting or racing tendency which causes so much wear and tear on the gate rigging.

The electrical apparatus of the first installation consists principally of five vertical type, revolving field, 3-phase, 40-cycle, 2,300-volt, 3,100-k.v.a. (at 75 per cent. power factor) generators, two vertical type 300-k.w., 300-r.p.m., 125-volt exciters, three transformers, 6,200-k.v.a., 3-phase, stepping up from 2,300 volts to 66,000 volts.

The transmission line is being built at present to Columbia, and consists of Milliken type, galvanized steel, double circuit

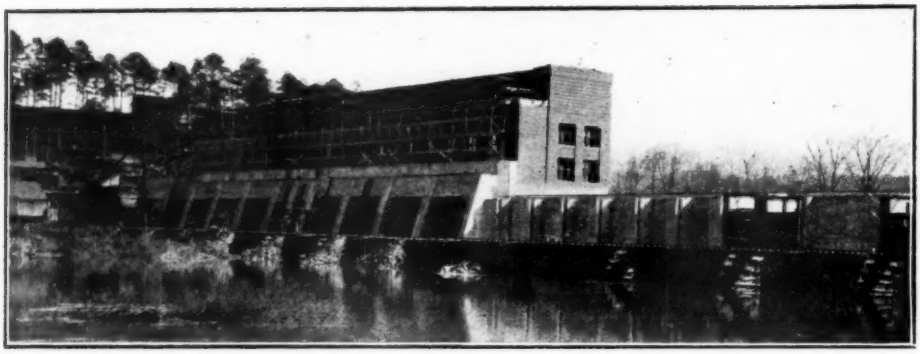
towers. The towers are spaced approximately 9.5 to the mile, with a height to the lowest cross-arm of 50 feet. In the city, latticed steel poles are used, spaced about 200 feet apart. Stranded medium hard drawn copper wire No. 1/0, 17-strand is used for power circuits, with a ground wire of 5/16-inch, 7-strand copper-clad wire of 30 per cent. conductivity. A telephone circuit of No. 10 copper-clad wire is run on a separate pole line, 35 feet from the center line of towers, with poles spaced 40 feet to the mlie. Thomas suspension No. 118 insulators, four in series, for suspension sets, and five in series for all strain sets, are used on power circuits.



POWER HOUSE *substructure on August 11, 1913. Note completed spillway sections of dam in the background.*

A substation located in Columbia has been built, which will also act as a distributing station for the present hydro plant and steam plant of the Columbia Railway Gas & Electric Company. All the power generated by these two plants, and the plant at Parr Shoals will be distributed from this station. There will be two distributing voltages 13,000-volt, 40-cycle, 3-phase, and 3,400-volt, 40-cycle, 3-phase. The latter is the present distributing voltage and phase of the Columbia Railway Gas & Electric Company. The building is of brick, with steel frame and concrete roof.

Authorization to proceed with the project was received in the latter part of June, 1912. Construction forces were immediately organized, camps built, wagon roads and railroads constructed in order to deliver material and plant as cheaply as possible. As the project was away from settlement of any size, it was necessary to provide accommodations for practically the entire force. At Parr Shoals the maximum of about eleven hundred men employed at one time with their families made a total population to provide for of about 1,500 people. Bunkhouses were provided for unmarried laborers, and houses having from one to five rooms were built and rented to the married men for from $2.00 to $12.00 per month. Four permanent houses were built on each job, for the future use of the power house operators, and were used during construction by the superintendents and engineers. Boarding houses, a butcher shop, bake shop, refrigerating and ice plant, and commissary were built. Great care has been taken to safeguard the health of the camps, pure filtered water and sewerage systems were provided, and a hospital, fully equipped, with a resident physician always in attendance. A sanitary inspector enforced all sanitary regulations. The wisdom of these precautions has been proved by the remarkable freedom from sickness in the camps. Malaria was very prevalent in the vicinity, but by using methods similar to those found so effective at Panama, this has given no trouble. For the protection of the camp, a fire brigade was organized, telephones and electric lights are also provided, and to keep the men contented, athletc sports have been encouraged, such as base ball, foot ball, tennis and trap shooting.



PARR SHOALS POWER HOUSE, *December 15, 1913, from upstream. Comparison of the two photographs will show the rapidity of construction.*

Work was started on the cofferdam at Parr Shoals the latter part of July. The first enclosure was completed in November, covering the site of the power house, sluice gates, and a section of the dam. The design adopted for the upper coffer consisted of a series of rock filled crib piers with 12-foot openings between, which were later closed by stop logs, or open cribbing, with the upstream face sheathed and toefilled. Later, and before the final closure was made, these openings were shot out, and the water passed thru to the sluice gates and temporary openings which had been left in the dam for this purpose. The balance of the cofferdams were usually a solid rock-filled-crib section, as this type can be built cheaper, and faster than the piers. A small amount of earth-filled-crib cofler was used. The coffer ranged in height from 6 feet to 27 feet, but usually was from 14 to 17 feet high.

Quarries and sand pits were opened, and very efficient stone-crushing and concrete-mixing plants were set up, having a capacity of 1,000 cubic yards of well mixed concrete per day. From the mixer the concrete was dumped in 2¼-yard buckets on flat cars, in trains of from four to six, and hauled by dinkies to site of work, and deposited in place by stiff-leg derricks. Eight locomotives of various tonnages from ten to forty, were used in this and on other features of the work.

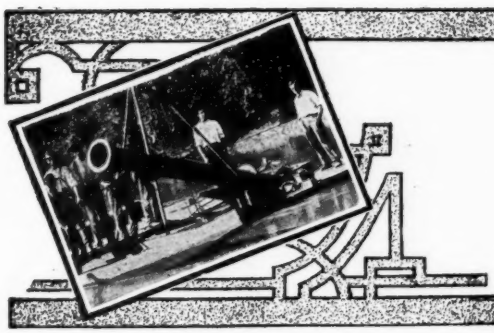
Concrete work commenced on February 5, 1913, and has continued practically uninterruptedly to date, practically closing the Parr Shoals dam except for temporary openings which cannot be closed until the work of raising and relocating about 5 miles of Southern Railway is completed.

The general scheme adopted was whenever possible to start the various features of the work at such times as would bring their completion as nearly as possible to the date of delivering power. In this way one of the most expensive items, that of interest during construction, is reduced to a minimum. Work on the substructure of the power house was started first; then the sections of dam, containing sluice gates and temporary openings, followed by the main dam, substation, transmission line, power house superstructure, and finally power house equipment.

The plant is ready to deliver power, only about a year and a half from date of beginning work, a very short time for a development of this magnitude.

Mr. E. W. Robertson, of Columbia, is president of the Parr Shoals Power Company.

The entire work of engineering and construction except the raising of the Southern Railway is being handled by The J. G. White Engineering Company, of New York, and assistance in financing has also been given by them.



# EDITORIAL

## FLOOD CONTROL LEGISLATION.

The legislature of Ohio has recently passed "The Conservancy Act of Ohio," which is intended to provide the machinery for the formation of "conservancy districts" for the purpose of preventing floods, regulating stream channels, reclaiming overflowed lands, providing for irrigation and regulating the flow of streams by means of excavating and changing water courses, building reservoirs, canals, levees, walls, etc., and to maintain, operate and repair the same. The general plan of the bill is not far different from that of drainage laws generally, except that the powers conferred are somewhat more extensive. The method of establishing districts by petition of individuals or a public corporation is ample, and the financial and administrative duties of the board of directors are set forth wth sufficient detail for all ordinary purposes.

Experience under similar laws suggests two sources of possible difficulty. Any court of common pleas within whose jurisdiction any part of the area of the district is located may be selected as the one to whom a petition may be presented. An area may be covered by more than one district if it belongs properly to more than one. While the judges of the courts are instructed by the bill to keep watch of duplications of petitions and double inclusion of territory and to meet and adjust any difficulties which may arise on account of contests over or duplications of jurisdiction, it is evidently possible for serious conflicts to arise between parties operating on different plans and attempting to head each other off.

Again, there is no check upon the competency of the service of the boards of directors and their employes and no provision is made for proper consideration of the rights and needs of districts above or below any district formed. Neither is there any method of fixing what the proper limits of a district should be, and but one, apparently inadequate, method of settling claims for damages made by parties outside the district.

These difficulties are ordinarily not serious in a drainage law, because the ordinary drainage district extends little beyond the county in which the principal part of its area lies, and by providing that the court within whose jurisdiction the major part of the area lies shall be the recipient of the petition, there can be no conflict of jurisdiction. And the ordinary drainage problems are local problems, affecting little area outside their own district. But this proposed Ohio law is broad enough to take in a river system covering several counties or any part of such a drainage area.

In order to correlate such large projects properly there should be some provision in the law whereby the suitability of the boundaries of the district, the sufficiency of the plans, and their conformity with the necessities of adjoining districts and localities farther below, and perhaps

above, can be passed upon by a state board having power to consider the problems of the state and of its various main streams and their watersheds. Such a board could aid largely in securing competent service for the drainage districts organized under the proposed law as well as in making all the work in the state conform to the necessities of the state.

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## BUILDING AND MAINTAINING ROADS FOR THE TRAFFIC.

To prevent excessive wear of its new roads the commissioner of highways of the state of New York has adopted rules and regulations for their use, which contain such restrictions regarding weights and speeds as the following:

No projections of flanges, rings, lugs, etc., beyond tire surfaces; no vehicle weighing more than 14 tons; no weight on tire of more than 800 pounds per inch of width; no vehicle more than 90 inches wide except traction engines 100 inches; speed limits of 6 miles for vehicles with metal tires weighing over 6 tons and 12 miles with rubber tires, and 15 miles for vehicles of 4 to 6 tons weight.

These regulations seem to steer between the two limits of demand, on the one side that the traffic should be limited to the character of the road surface absolutely, and on the other that the road should be so constructed that it will stand any traffic which may offer, and thus to approximate the most economical and practical system.

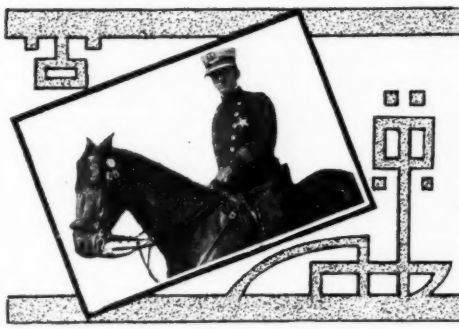
Limitation of traffic to the character of the road restricts development of the traffic, keeps farm products out of the best markets at the best times, restricts the kinds of such products which can be grown, by making traffic more or less difficult and increasing its expense.

Meeting the demands of the heaviest traffic imaginable enforces the construction of the most expensive pavements and bridges and thus costs more than the benefits possible in the utmost development of the traffic, with the exception perhaps of some such cases as hauling of mine or factory products.

The best results are obtained by following a middle course, the exact location of which must be determined by the demands of the locality, and the upper limits of allowance of high cost pavements are set by the New York regulations. These really apply to main roads and the branch roads and neighborhood roads do not require such high limits. Indeed, it might be well to limit still more the weight and speed of vehicles used on the less traveled roads, particularly the speed, until such time as the economics of the question have been fully developed and we know more than we do now of the effect of road improvement upon the development of the country and the future increase in traffic.

Much money has been wasted by building roads too good for the traffic to be carried and quite as much money has been wasted by building roads too light for the legitimate traffic developed by the improvement, which must afterwards be rebuilt at large additional cost. We have learned some expensive lessons on this line.

The state of New York may still waste money if it attempts to build all its state and county roads equal to the standard practically set by the regulations mentioned, for the amount of such traffic over many will not warrant the highest class of road surfaces. It will even be better to increase the cost of maintenance as may be necessary for the small amount of such traffic carried if a double set of traffic regulations is not deemed advisable.



# QUESTION DEPARTMENT

## Method of House Numbering

McDonald street begins four blocks south of George street, the east and west center line, and runs south. Should the house numbers begin with 100 or with 500? Similarly, Nelson street begins six blocks south of George street. Should its house numbers begin with 100 or with 700?

M., Town Engineer,
———, N. S.

If the numbers are to show the number of blocks from the central axes of coordinates the house numbers should run without reference to the point of beginning of the street and, according to the system used in the town, McDonald street house numbers should begin with 501.

It is noted that the numbers begin with 101 at George street, the east and west base line, so that Number 200 is one block from that street, 300 is two blocks away, etc. This has the advantage that the numbers in the first block are all 100 plus, those in the second block 200 plus, etc. The writer prefers the method of beginning numbers with 1 at the base line, because then they represent the distance from the base line street, 250 being 2½ blocks from the base line, etc.

The real difficulty in the town under consideration is the method of numbering East River road. This is a diagonal street beginning at the same point that McDonald street begins, four blocks south of George street, the east and west base line, and one block east of East River, the north and south base line. If it is to be considered as an east and west street, tho it runs southeast, its house numbers should begin with 200 under the town system, but if it is to be considered as a north and south street its numbers should begin at 500, the same as McDonald street. This must be determined according to the relative importance of the streets, or possibly by the name.

East George street runs east from the river. East River is apparently a street on the east side of the river and runs north and south and would be numbered as other north and south street are numbered. East River road, running southeast beginning one block east of East river, would probably be most easily kept straight if it were numbered as a north and south street. This double use of "East" will make difficulties in any event.

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## Where Should the Coagulant Be Added to Water

We should be glad if you will give us some information on a subject that is of vital importance to the city and citizens of this city at this time. This city uses water from one of its rivers for all domestic and manufacturing purposes. The water is pumped up into a reservoir and settling basin, from which it is filtered thru sand filters into a clear water basin, using an average for the year of a little over one grain of alum in solution per gallon of water for coagulation. Of course, the amount of alum added, from time to time, depends upon the condition of the water in the river. This alum solution at present is allowed to enter the flow pipe leading from reservoir to sand filters. It has been recommended that this alum should be added to the water just before it flows into the settling basin to allow some little time for proper coagulation. A so-called expert recommends that this alum be allowed to enter the suction pipe to the pumps at the river, thereby allowing the solution to flow with the water thru the pumps and 1,600 feet cast-iron pipe discharge before entering the settling basin. The question is, will not this alum solution going into the pumps and discharge pipe, day after day, be of serious injury to both pumps and pipe?

Your impartial reply to this will be greatly appreciated.

M., City Clerk,
———, Ga.

We shall be glad to publish statements from our readers of their experience in this matter.

The office of the alum being to coagulate certain classes of impurities in the water and put them in condition to settle out, it is apparent that the same should be added before the water has entered the settling basin. In this manner the solids which clog the filters will be removed in large part in the basin and the filters will be relieved of much work, will not be clogged so soon and need not be cleaned so often. Whether the reservoir should be used as

a settling basin or whether special basins should be provided for the settling process must be determined from knowledge of the kind and purpose of the reservoir, ease of cleaning, etc., concerning which the question gives no information.

It is desirable to mix the alum with the water as thoroly as possible before the settlement is begun, and passage thru the pumps would do this, but passage thru the 1,600 feet of main might permit settlement in it which would clog the main and require cleaning at intervals. It is customary to add the coagulating chemicals just before the water enters the settling basin in such manner that they are thoroly stirred into and mixed with the water.

## Makers of Patrolmen's Equipment

I wish the addresses of concerns making or selling police goods, such as clubs, cuffs and general patrolmen's equipment,

H. D. J., ———, Me.

Manufacturers of uniforms can doubtless supply all that is desired, such as M. C. Lilley & Co., Columbus, Ohio; Olhm & Co., Baltimore, Md.; Royalton Woolen Company, 70 Worth street, New York; Wm. Shapiro, 587 Fifth avenue, Brooklyn, N. Y.; Wendell, Fay & Co., 82 Worth street, New York. E. B. Estes & Sons, 74 Warren street, New York, supply police clubs.

## Municipal Central Station Heating for Small City

Can you tell whether municipal heating is an attractive proposition for a city of our size? We have two school buildings about eight blocks from the city water, light and power plants. It has been suggested that we utilize the waste steam from the power plant in heating our two buildings. It has also been suggested that the city furnish heat for the business section of the city which is located between our buildings and the power plant. Any information you can give will be appreciated. S., ———, Ind.

Some very successful small plants have been established and some have been failures. Good engineering in the design and construction and permanent, competent management are essentials.

A brief illustrated article in the February number of MUNICIPAL ENGINEERING will indicate the possibilities and some of the troubles. The question is well worth investigation, for which purpose an expert should be employed who would not be interested in the construction of the plant to such an extent as to bias his view of the subsequent operation. Distance is not so great a factor in computing efficiency as it was formerly, and there is often considerable economy in using the exhaust steam from a light, power or water plant.

Some years since MUNICIPAL ENGINEERING published quite full statistics of the plants then in existence. There are now many more, and the methods of design and construction have been well standardized.

Gifford's "Central Station Heating" ($4) will give much detailed information as to methods and results and some data as to cost of construction and operation and the determination of rates.

## Well-Drilling Machinery Makers

This city is contemplating a change in the source of her water supply at the municipal water plant. We are at present pumping from the river, and contemplate changing to some drilled wills.

Could you kindly give me a list of names of people who make machinery or who have patents for this class of work.

We will need an outfit to pump about four and a half million gallons of water per day.

T., ———, Ky.

Prominent makers of such machinery are the American Well Works, Aurora, Ill.; Austin Mfg. Company, 910 South Michigan avenue, Chicago, Ill.; Keystone Driller Company, Beaver Falls, Pa.; Oil Well Supply Company, Pittsburgh, Pa.; Southern Well Works, Chattanooga, Tenn.; St. Louis Well Machine and Tool Company, St. Louis, Mo.

## Methods of Street Lighting for Special Occasions

Will you kindly inform us where we may be able to obtain information relative to some of the more recent and more effective methods of special street lighting for specal occasons, such as conventons and celebrations, which may have been employed by some of the larger cities of the country?

For several years we have maintained on Nicollet avenue, our chief retail street, a system of overhead wire arches, bearing incandescents. These have ceased to be a novelty, and we have decided to discard them entirely. A committee of retail merchants of this association has been appointed to develop some more novel and less expensive plan for special illumination. You know that we have one of the best developed systems of ornamental light standards, covering practically our entire business district, to be found anywhere. What we seek now is an auxiliary and circus-sort of scheme for state fair and holiday week.

We shall be deeply grateful if you can refer us to any city which has accomplished anything striking along this line, and we thank you for any attention you may find it possible to give this communication.

E. C. HILLWEG, Assistant Secretary,
Civic and Commerce Association,
Minneapolis, Minn.

The various cities which entertained the Perry celebration with the rebuilt flagship of his little Lake Erie fleet, used methods of illumination which would give some excellent ideas for special lighting for special occasions, notably Cleveland, Buffalo, Erie and Milwaukee. New York City has had some wonderful results from special lighting plans for celebrations. St. Louis has done some

fairly good work of this sort. Denver and New Orleans could also give some ideas. The expositions, great and small, are also sources of good suggestions. Possibly the lighting plans of the San Francisco Exposition are sufficiently developed to afford some assistance.

This sort of lighting has become almost a necessity of special occasions and is worthy of the special study of an illuminating engineer of artistic tendencies. The best results will be obtained by the employment of such an expert to work out the plans and their details after the necessary conferences with those interested in the results and in paying the bills.

The secretary of the Illuminating Engineering Society, I. S. Israel, 29 West Thirty-ninth street, New York, may be of assistance in this matter.

## Ordinance Governing Electric Current Meter Inspection

I would like to have a copy of a representative ordinance governing the inspection of watt-hour meters if you can furnish the same. If you have not this, can you give me some information regarding the percentage of error that is allowed in such a meter, and can you inform me as to whether or not it is customary to test at three loads (light, medium and heavy), and whether it is customary to require the reading to be correct, within the allowed percentage of error, at each of these loads. Would also like to know what would be considered as light load on a 5-ampere house meter.

S., City Engineer, ———, S. D.

The Massachusetts law on this subject may serve as the basis for a city ordinance. It reads as follows:

"A customer of an electric lighting company or such company may apply to the board of gas and electric light commissioners for an examination and test of any meter in use upon a customer's premises. The board shall forthwith cause to be made by a competent and disinterested person such examination and test of said meter as in the judgment of the board is practicable and reasonable, and shall furnish to the company and to the customer a certificate of the result and expense thereof. If upon such examination it appears that the meter does not register correctly, the board may order the company to correct or remove such meter and to substitute a correct meter therefor. All fees for examination and tests shall in the first instance be paid by the person or company making application therefor; but if the examination or test is made at the request of a customer and the meter is found to be incorrect because too fast the company shall pay such fees to the board, to be repaid by it to the applicant. A meter shall be deemed correct for the purposes of this section if it appears from such examination or test that it does not vary more than 5 per cent. from the standard approved by the board."

In the latest report of the Massachusetts Board of Gas and Electric Light Commissioners are reports of tests of six five-ampere meters. Their percentages of error were as follows:

| No. of inspection. | At 1/5 load. % Fast. | At 1/5 load. % Slow. | At ½ load. % Fast. | At ½ load. % Slow. | At full load. % Fast. | At full load. % Slow. |
|---|---|---|---|---|---|---|
| 399..... | 396 | 1.8 | ... | 0.5 | 0.6 | ... |
| 399..... | 2.0 | ... | 1.7 | ... | 2.3 | ... |
| 401..... | ... | 1.0 | 0.7 | ... | 0.5 | ... |
| 414..... | 0.6 | ... | ... | 0.1 | ... | 0.1 |
| 422..... | 3.3 | ... | 1.3 | ... | 3.0 | ... |
| 428..... | ... | 1.7 | 0.3 | ... | ... | 0.1 |

## Garbage Disposal for Small City

This city is desirous of securing access to information in relation to garbage disposal plants which may have been published in your magazine within the last two or three years.

This city, as you probably know, has about 20,000 inhabitants and the garbage disposal problem is becoming a pressing need.

If you have in convenient form a list of cities of about this size who are operating plants, we would be appreciative of a copy of the same.

R. K. P., City Attorney, ———, Ore.

Following are the articles which have appeared in MUNICIPAL ENGINEERING regarding garbage disposal within the period mentioned:

In vol. xlii: Garbage Disposal for Small Cities, p. 250; List of Articles on Garbage and Refuse Collection and Disposal, p. 252; Statistics of Proposed Garbage Collection and Disposal, p. 320; Automobile Garbage Trucks in Cleveland, p. 328; Disposal and Collection of City Wastes, p. 385; Street Cleaning, Garbage and Refuse Collection and Disposal, p. 468.

In vol. xliii: Motor Garbage Trucks in Homestead, Pa., p. 53; Ordinance Requiring Weed Cutting and Refuse Removal, p. 254; An Individual Garbage Destructor, p. 257; Chicago Garbage Removal, p. 327; A Book on Garbage Destruction, p. 329; Methods of Garbage Collection, p. 391; The Collection of Refuse, p. 414.

In vol. xliv: Automobile Truck for Refuse and Street Sweepings, p. 119; Statistics of Proposed Garbage Disposal, p. 229; Garbage Disposal in Canton, Ohio, p. 241; Makers of Garbage and Refuse Destructors, p. 330; Information About Garbage Disposal, p. 519; The Question of Garbage Disposal, p. 572; Refuse Destructor at Halifax, N. S., p. 582; Garbage Destructor for Los Angeles, p. 584.

In vol. xlv: Garbage and Waste Disposal, Mixed Method, p. 25; Sewage and Garbage Disposal Methods, p. 43; Motor Trucks for Removal of Garbage, p. 260;

Results of Garbage Reduction at Columbus, Ohio, p. 321; Free Garbage and Refuse Collection in Schenectady, N. Y., p. 366; Facts About Collection of Garbage and Refuse, p. 366; The Destruction of Garbage on the Premises, p. 402; Garbage Disposal in Chicago, p. 441; Refuse Disposal Methods as Adapted to Chicago, p. 528; Recoverable Values of Municipal Refuse, p. 550; Destruction of Garbage on the Premises, p. 562.

In vol. xlvi: The Refuse Destructor at Northampton, Eng., p. 8; Municipal Garbage Reduction and Destruction Plants, p. 35, gives the list desired; Incinerating Plants Producing Power, p. 40; The Refuse Incinerator at Moose Jaw, Can., p. 161.

## Specifications for Laying Natural Gas Pipe

I am desirous of obtaining a specification for the laying of natural gas pipe in city streets, especially in reference to provision for temperature contraction.

A company supplying natural gas to the town laid, last summer, 1,000 feet of 3-inch pipe, 18 inches below the surface of ground, with but one expansion joint. When cold weather came the pipe broke from some cause, and the escaping gas entered a dwelling and caused an explosion.

I have looked over back numbers of Municipal Engineering, but think books mentioned refer only to manufactured gas plants. A., ———.

Can any of our readers supply such specifications? The specifications for laying natural gas pipes would ordinarily be less strict than for artificial gas because the trouble from condensation is less and so the provisions for drainage of pipes are not so elaborate. Pressure on distribution pipes are no greater. The supply mains, however, are under greater pressure and must be more carefully laid and with stronger joints. Provision for expansion and contraction is seldom necessary in city streets because the pipes must be laid deep enough to get them beyond dangerous variations in pressure. In a cold climate the pipes should be laid deep, and this is probably the defect in the specifications under which the pipe in question was laid.

In the open country natural gas pipes are often laid uncovered or very slightly covered, but the departures of the pipes from straight lines give opportunity for expansion and to some extent for contraction. Breaks in the pipes are not infrequent, but are seldom dangerous.

In the early days of natural gas there was much fear of such explosions as that named and some city ordinances provided systems of protection, instead of requiring improvement of the specifications. The Indianapolis ordinances provided the following safeguards:

"All pipes, mains and apparatus of every kind and description used by any corporation, individual, firm or company accepting the provisions of this ordinance shall be of the most approved design and quality. All pipes shall be standard weight."

"The mains and service pipes shall also be so laid in the public streets, alleys, avenues, lanes and public grounds of said city as to prevent the escape of gas and in such manner as that the use of the gas will be safe."

"In order to provide against gas that may escape from high or low-pressure mains and pipes from passing into cellars, sewers and buildings, it shall be and is hereby made the duty of all such corporations, companies, firms and individuals laying mains and pipes for carrying gas as aforesaid when deemed necessary by the city civil engineer and said common council and board of aldermen to provide, furnish and supply a system of escape pipes to be approved by the city civil engineer and said common council and board of aldermen sufficient to carry off any and all gas which may leak or escape thru defective joints, service pipe connections or defects in the mains. Gages showing the amount of pressure on all natural gas lines shall be erected at the expense of such corporations, companies, firms or individuals, and shall be open at all times to public inspection, and located at such points as may be directed by the city civil engineer when concurred in by the common council and board of aldermen, and it shall be and is hereby made the duty of said engineer to notify such corporation, company, firm or individual to reduce or cut off the pressure upon such line or lines as the public safety from time to time may require."

"The top of any and all natural gas mains laid under the provisions of this ordinance for the purpose of conveying or supplying natural gas in said city shall be placed at a depth of not less than 3 feet below the surface."

"The maximum pressure allowed on any or all high-pressure mains within the limits of the city of Indianapolis shall be 20 pounds per square inch. The maximum pressure allowed on any and all low-pressure mains within the corporate limits of said city shall be 8 ounces per square inch," with a provision for special permission for higher pressures under special precautions. All mains were tested before use at 80 pounds per square inch for high-pressure lines and 10 pounds for low-pressure lines, service pipes being tested for the same pressures as the mains to which they were attached.

The escape pipes described were put in and were of some use in leading gas leaked from mains to standpipes, where it could be burned if the leakage were con-

stant, but as the supply of gas was reduced and it became more valuable leaks were stopped, and in the later years there was no more trouble than on artificial gas lines, where tight joints were required by reason of high cost of leakage.

The development in recent years of high-pressure distribution of artificial gas has brought about an improvement in specifications for materials and workmanship and in design of the high-pressure lines, which is more elaborate than the ordinary requirements made of natural gas companies where natural gas is abundant and cheap. These specifications should be used for natural gas construction.

Street main joints are illustrated in a paper by W. A. Learned before the New England Association of Gas Engineers in February, 1903.

In replies to questions given by seven prominent gas engineers, provision for expansion where lines cross bridges and are therefore more subject to changes in temperature is made in high-pressure gas distribution mains by two, but not otherwise; three use expansion joints, one occasionally and one every 500 feet; two make no special provision for expansion.

Tests in St. Louis of cement joints and others indicated great difficulty in making tight joints on high-pressure gas mains.

## Earth as a Paving Material

We have understood that there was a pavement which is made out of common dirt by mixing it with some sort of material, and we would be pleased to know if you can give us the address of the firm handling this kind of pavement? J., City Attorney,
———, Kan.

Possibly the bitu-mass pavement developed by the American Paving and Manufacturing Company of Indianapolis, Ind., is the one referred to.

In the beginning it was assumed that this pavement could be made out of old macadam or gravel streets by digging up the gravel or stone, running it thru the machine, heating and mixing it with bituminous material and redepositing it on the street and rolling it into place. It was soon found that this would not give a sufficiently solid pavement, so that it was necessary to add what was called grit to the material found on the street. Still later it was found that a uniform pavement could not be produced without using a more uniform material, so that they used new material entirely.

Possibly the petrolithic pavement is the one referred to. This process is reported to work best in sandy soil, but has been applied to all kinds. It consists in compacting the sub-soil as thoroly as possible by means of a special tamping roller and treating the roadway so prepared with oil, alternately, until a comparatively hard bituminized surface is secured, as described in MUNICIPAL ENGINEERING, vol. xlv, p. 246.

## Directory of American Cement Industries

We would like to inquire if you have as yet published the 1914 directory of the American cement industries, and if so what is the price of the same?
G. L. SIMONDS & Co.,
Chicago, Ill.

No recent edition of the Directory of American Cement Industries has been published. The *Cement Era*, 1207 Morton building, Chicago, Ill., publishes a Directory of American Cement Manufacturers which gives full information about cement factories, companies, brands and sales agents. The 1914 issue is out and costs $1.

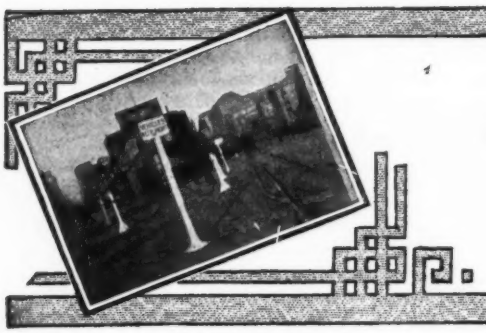
## Drill for Inspecting Cement Pavements

We have an inquiry for a tool which is used to test or rather inspect cement roadways.

We understand this is in the shape of a hollow drill which turns with a handle and takes out a plug the entire thickness of the cement, grinding about ⅛ inch diameter.

Perhaps you can put us next to such an article and let us have a circular of same.
JONES HARDWARE COMPANY,
Richmond, Ind.

A small core drill is what is described, and it can be obtained of the manufacturers of such drills, among whom are the American Diamond Rock Drill Company, 90 West street, New York; American Drill Works, Aurora, Ill.; Cyclone Drill Company, Orrville, Ohio; Ingersoll-Rand Company, 11 Broadway, New York; Sullivan Machinery Company, People's Gas building, Chicago, Ill.



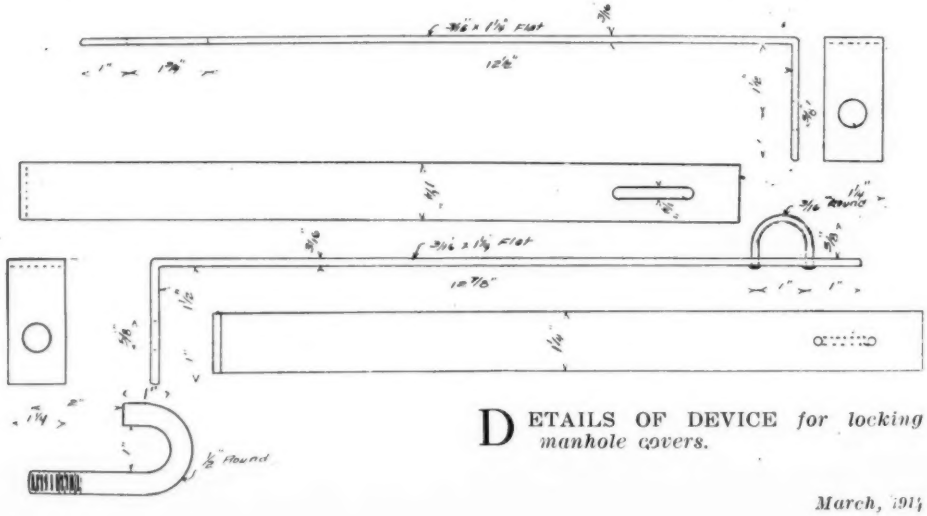
# WORKERS IN THE FIELD

## Device For Locking Sewer Manhole Covers.

The Editor of MUNICIPAL ENGINEERING:

Sir—Some time since the writer described a device which has been used successfully in this city for locking the covers of sewer manholes in place so that boys and others could not remove them and deposit rubbish, etc., into the smaller sanitary sewers and cause them to become clogged. As shown on the accompanying plan it consisted simply in two wrought iron hasps, each held in place at the side of the casting by a one-leg U-bolt, and meeting at the center of the cover where they were fastened by means of an all-brass, or other non-rusting padlock. As stated in the above mentioned article, this scheme worked well on those castings where it was necessary to raise the lid something like two inches vertically before it could be pushed laterally off of the frame. However, a great many of our manholes, especially on the older sewers, are capped with a casting so arranged that it is only necessary to raise the edge of the lid from one-half to three-quarters of an inch to be able to shove it off of the frame. With the class of mechanics one usually gets to do this kind of work, it is practically impossible to get a close enough fit with the hasps but that one edge, at least, of the lid can be lifted a half inch or more, especially if the castings vary slightly in size. So it was deemed expedient to try some other arrangement, and the following method was devised, which does the work and is cheaper than the first device.

Instead of using hasps, three short pieces of open link chain are used. They are fastened to the frame by eye-bolts set in holes drilled in the side of the casting and meet at the center of the lid, where they are fastened with a suitable padlock as in the former case. The eye-bolts are spaced equi-distant around the circumference of the outside of the casting, and are so placed vertically that when the lock is in place the chains are as tight as is possible to get them. That is, the final adjusting is done in spacing the last eye-bolt, for the reason that the lengths of the links in the chain vary considerably. In this way, tho the lid may be lifted vertically enough to clear




DETAILS OF DEVICE *for locking manhole covers.*

the seat on the frame, it is impossible to shift it very far laterally, for the reason that the straight line distance between any two eye-bolts is less than the diameter of the lid. The disadvantage of this scheme over the former is that three holes are required to be drilled in the castings instead of two, but this is more than offset in the amount of blacksmith work necessary to be done.

With the first device used it was found that they could not be put on the manholes at a cost much less than $2.00 each, which included the padlock and everything. A machinist was paid 60 cents per hour for drilling the holes and placing them, and it took about an hour for each one, including time lost moving. With the latter method the work was done by a regular employe of the city, who, by the way, was a first class man for that sort of work. He did all the blacksmith work as well as the drilling, and, including the cost of a good secondhand ratchet drill, these last twelve locks were placed at a cost about 80 per cent that of the former. The following data give the cost of making and putting in place twelve complete fastenings:

| | |
|---|---|
| Chain | $ 2.20 |
| Material for eye-bolts, scrap | 0.00 |
| Padlocks | 4.80 |
| One man. blacksmith and machinist, 3½ days at $2.75 | 9.63 |
| Total cost for 12 | $16.63 |
| Each | $1.39 |

The outside diameter of the castings was about twenty-seven inches, so each piece of chain was about fifteen or sixteen inches in length.

The locks were a regular fifty-cent Corbin lock, all brass except the eye, which was steel. This particular lock was selected because the keys were flat and so arranged that by filing out all notches between the two exterior notches on each side. any one key could be made into a master key that would open all the locks. On the first set of fastenings put on, each lock could be opened only with its particular key. These were numbered and tagged, but upon using them the first time after they had been placed it was found that the tags had come off while being carried in the pocket. and it was necessary to try each key in each lock until the proper one was found. Hereafter all locks will be of one pattern so that one key will open all.

It took two and one-half days to put the fastenings in place on the castings. One reason for taking so much time was that most of the manholes were located on the outfall sewers and were in inconvenient places to get at. Also they were scattered from one side of the city to the other and considerable time was lost in moving from place to place. The castings were generally about one and one-half inches in diameter and the drill bit was long, and for that reason care had to be exercised in working the feed screw to not buckle and break the bit. It was found that with a sharp bit a hole could be drilled in about ten minutes. tho after the bit had become dull. or when a particularly hard casting was encountered, it frequently took as much as fifteen minutes per hole. Had the bit been some larger, say five-eighths or half-inch, and with a short shank, I believe each hole could have been drilled in five or six minutes.

The ratchet was worked on the inside of the manhole, supported by blocking against the opposite side of the casting. In placing the first set of fastenings the drill was worked on the outside of the castings, employing what is known as an "old man" to support the ratchet. This was made from a piece of ½ by 3-inch flat and bent to fit over the top of the casting. It was necessary to use care and not feed the drill too fast, and even then considerable time was lost in taking the "old man" off and straightening its back.

E. W. ROBINSON, City Engineer,
Webb City, Mo.

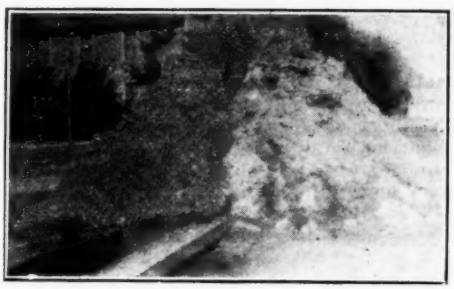
## Difficult Cleaning of Sewers

The Editor of MUNICIPAL ENGINEERING:

The picture herewith shows gravel which was removed from a section of our Washington street sewer from a 300-foot section of 15-inch pipe.

We later encountered much worse conditions in our Franklin street sewer. In this we found pieces of brick and wood, sand and gravel, besides tin cans and numerous other things. These obstructions were packed so solidly in the sewer that it was only after considerable effort that we were able to dislodge them.

In St. Paul street, a 12-inch sewer was laid several years ago with pipes made



GRAVEL *removed from Wausau sewer.*

ROOTS *removed from St. Paul street sewer, Wausau, Wis.*

from cement and sand; from this were taken the roots shown in the picture. This is the third time within the last eight years that we have been compelled to remove roots from this sewer. Previously we were compelled to dig up the sewer and break the pipes to remove the masses of roots that had formed. This year, however, we were successful in removing the larger portion of the growth with the sewer cleaning machine In fact, after we secured the machine from the Turbine Sewer Machine Renovating Company, of Milwaukee, we succeeded in cleaning most of the sewers with which we had experienced trouble. We have also used the sewer cleaning machine to good advantage in removing tar which had entered one of our sewers from our gas plant. The work of removing tar is somewhat difficult and unpleasant but by applying considerable water pressure to the machine, we were able to force the tar ahead of it and afterward to remove the tar from the manhole where the machine had been at work.

H. E. MARQUARDT, Comptroller,
Wausau, Wis.

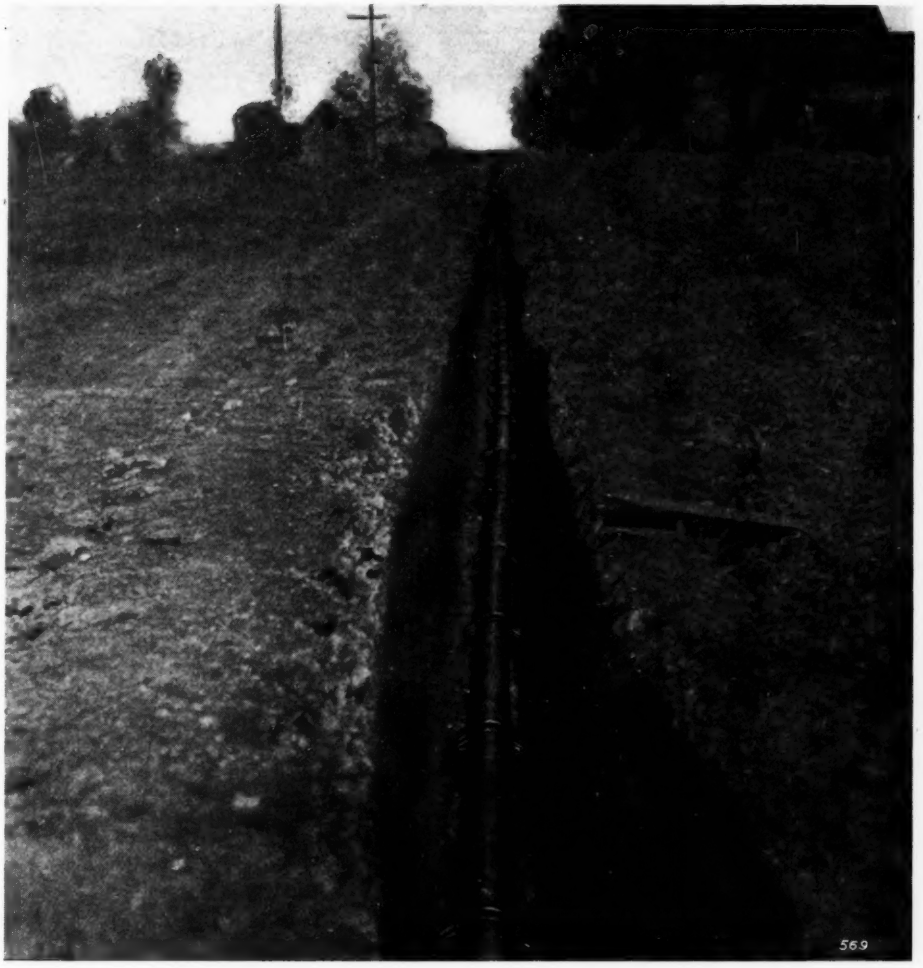
## The Water Works of Payne, Ohio

The Editor MUNICIPAL ENGINEERING:

Sir—A description of the water works of Payne, Paulding county, Ohio, is herewith given, as it is of interest as to the methods of laying and testing the water mains. Universal pipe was used for the water mains, this pipe having turned male and female joints bolted together and held by two lugs on the side of the pipe. This construction was used thruout except at the hydrants, the hydrants having ordinary lead joints.

The village, which has a population of about 1,200, is supplied thru a distribution system having a total length of 18,000 feet of pipe, 34 fire hydrants and 23 valves. The system comprises 751 feet of 8-inch pipe, 2,177 feet of 6-inch pipe and 15,037 feet of 4-inch pipe. The fire hydrants are distributed in the manner shown on the plan and the town has excellent fire protection. Special attention was given to the placing of fire hydrants in the business district in order to get good fire protection there. At the same time special care was taken that no water mains be laid under brick-paved streets, but they have crossed the paved streets in a number of instances. In other parts of the town the brick streets do not extend the full width and as there was a large space between the sidewalk and the street, the water mains were laid in this space. This resulted in considerable saving in the laying of the mains and a ditching machine was used thruout the work except in some of the alleys. The pipe is laid in a 4½-foot trench, a Buckeye ditching machine being used. After inspection and testing of the pipe the back fill was scraped back with a team and scraper, and after the entire work was completed the top of trench was trimmed in a neat manner for future settlement. A large portion of the work was done during wet

WATER TOWER *and tank at Payne, Ohio.*

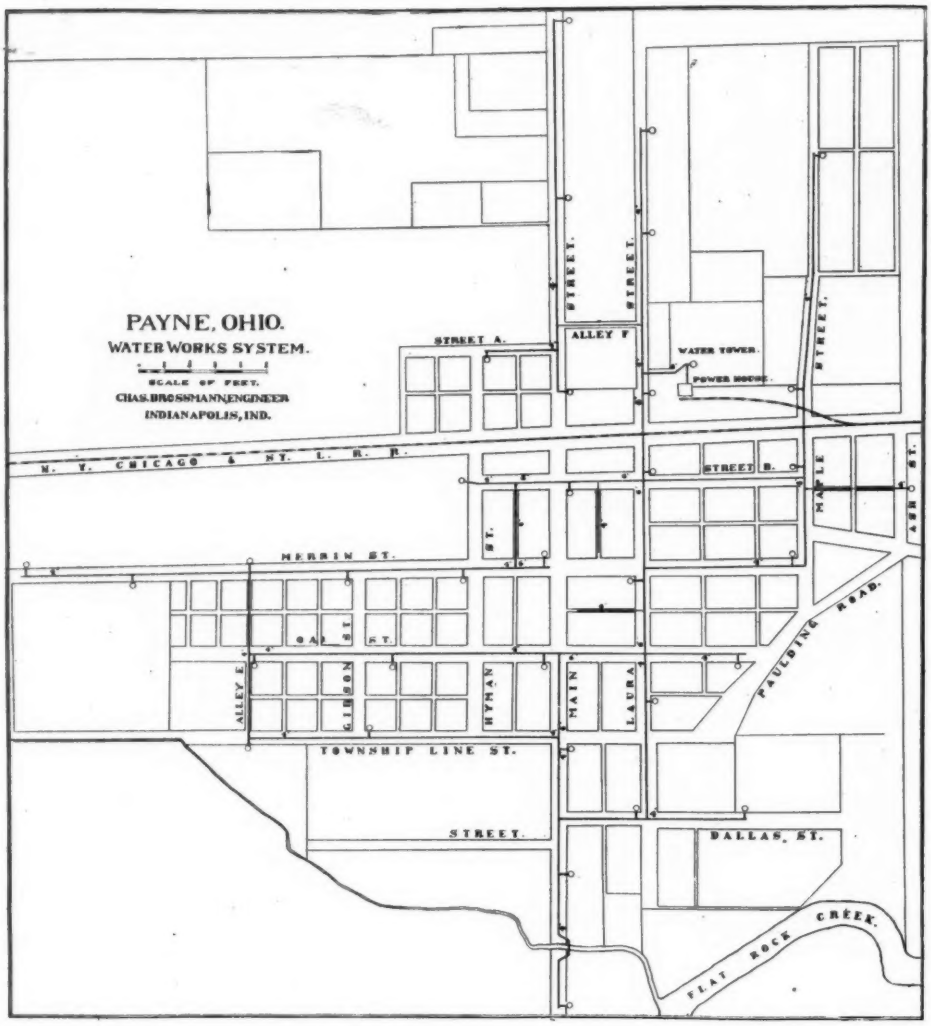


PAYNE WATER WORKS. *Pipe-laying and trenching; pipe ready for test.*

weather and in the winter season. The type of pipe, however, was favorable for laying in this kind of weather and no difficulty was experienced in getting a good installation. The work of laying was started at the water tower, connections being made to the well and pump at the plant. As each section of the main was laid the pipe was tested in open trench for leaks, the pressure being run to 160 pounds per square inch, and all work was tested in this manner except at a few points where it was necessary to back-fill at once. There were a few leaks, from which the amount of water was usually very small, and these were taken up very easily by tightening the joints. These few leaks were usually due to either the pipe not being cleaned or wiped before putting together or to the pipe not being properly lined up. The leaks, however, were easily and quickly taken up in most cases. As much of the trench was left open as possible before back-filling in order to get subsequent tests on the pipe after the first tests, as high as 4,000 feet being left open at a time. After the entire line was installed tests were then put on for a number of hours and as the water tank was completed before the pipe line, the tank was then filled and left standing. In a period of 12 hours no loss in pressure was shown on the gage from the tank. The line has been very satisfactory as to tightness.

The water tower and tank were furnished and built by the Flint & Walling Company and the tower is 100 feet high to the bottom of the tank.

The hydrants and valves are Ludlow, the hydrants being the standard 4-inch two-nozzle type. The threads on the hy-



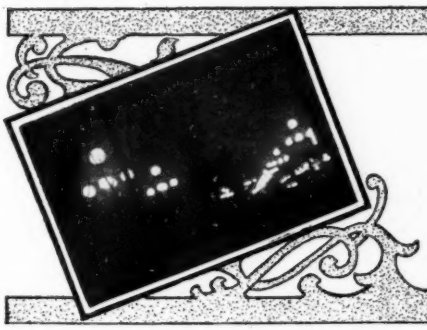

MAP OF WATER WORKS *distribution system of Payne, Ohio.*

drants were made the same as the threads at Ft. Wayne, which is about 25 miles away, so that in case of a large fire outside assistance could be secured.

At the present time the village is using the water from a well at the electric light plant, the present pump in the plant being used to supply the system with water. This water is taken from a well about 300 feet deep, the limestone being struck at the depth of about 50 feet. The water at present is being used simply for sanitary and sprinkling purposes, as the original plans contemplate the installation of a well and an electrically driven pumping station away from the more thickly populated district of the town. The entire distribution system cost $10,765, which included all pipe, hydrants, valves and laying of same. The engineer's original estimate on the distribution system was $10,818. The water tower and tank cost $3,175. The contemplated cost for all work, including the proposed electrically driven pump, will be in the neighborhood of $17,000 when the entire plant is completed.

The writer, Merchants' Bank building, Indianapolis, Ind., was consulting and designing engineer and the pipe work was installed by the National Company of South Bend, Ind.

CHARLES BROSSMANN,
Consulting Engineer.
Indianapolis, Ind.



# WATER

## Water Works of Spokane, Wash.

The plan of the Spokane water works is somewhat complicated, due largely to the desirability of dividing the area to be served into one low, two intermediate and one high service district, the extremes of elevation being 1,780 and 2,400 feet above mean sea level.

The main pumping stations are located on the Spokane river east of the city limits, where the water is taken from two wells, each 30 feet in diameter and 39 feet deep, having steel casings perforated with ¾-inch holes in the lower 10 feet and brick walls above. There is plenty of water in the strong flow in the coarse gravel stratum reached by the wells, pumping at 35,000,000 gallons a day from one well only lowering the level 44 inches. There is a variation of level in the water of 14 feet at different seasons of the year.

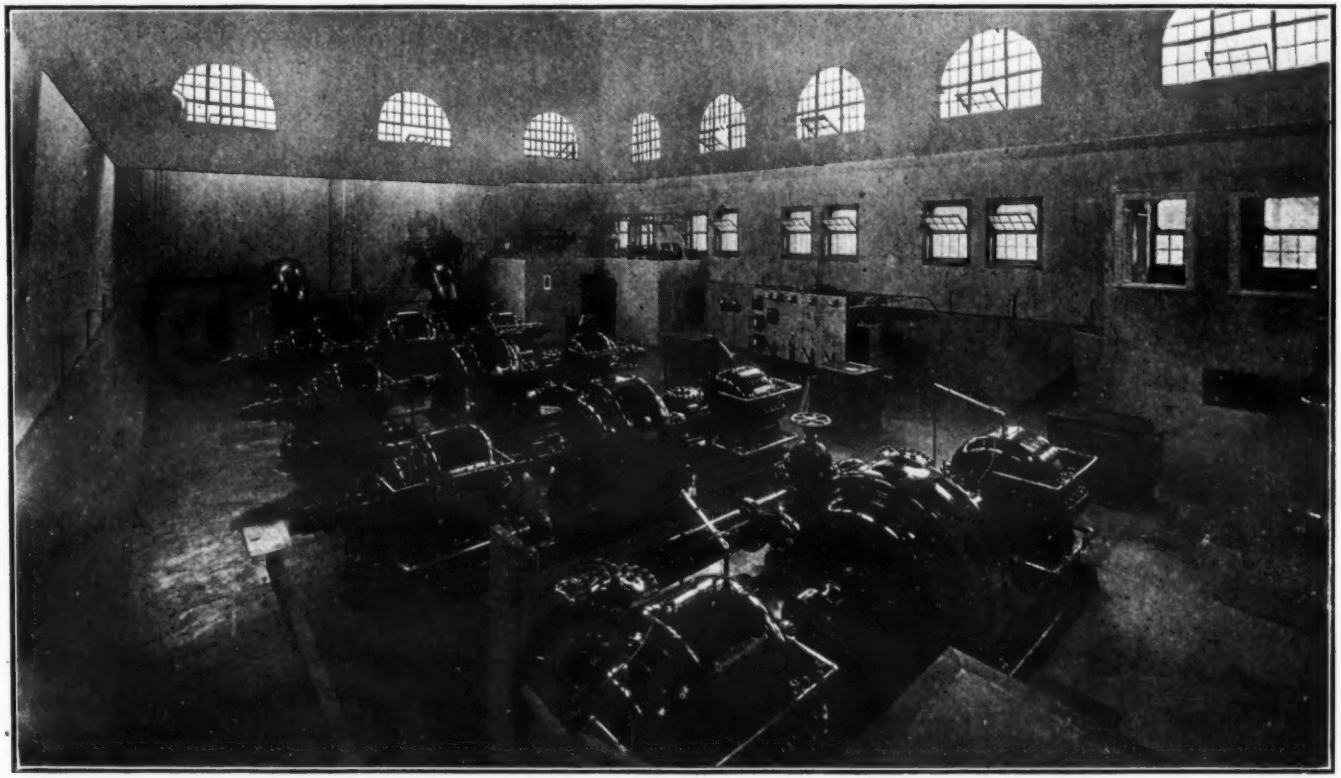
The old pumping station, built in 1894, with several additions since, contains seven 54-inch and two 60-inch turbines built at several dates from 1889 to 1907, supplied with water power from a dam about a half-mile above the station. These turbines drive two 30-inch Morris centrifugal pumps, which together can lift 57,600,000 gallons a day from one of the supply wells into three concrete suction wells of 8 by 10 feet dimensions, with an average total head of 20 feet, nearly equally divided between suction and discharge; also 12 Holly pumps of 2,500,000 gallons rating and one of 4,500,000 gallons, which pump into the low-service mains under a pressure of 115 pounds, 5 being connected with a 24-inch main and 11 with a 36-inch header, which branches into a 24 and a 30-inch. Four of the pumps are also connected with a 28-inch intermediate-service main, which they supply under a pressure of 170 pounds.

A new pumping station was built in 1910 near the old one, which has also been added to since and now contains four units, each driven by a 900-h.p. induction motor and containing two multi-stage centrifugal pumps direct connected to the shaft, the total pumping capacity of the new station being 50,000,000 gallons a day. The maximum suction lift of these pumps is 16 feet, and they are connected with both the low and the intermediate services; each thru a 30-inch main. The pumps of each unit are so connected that they can be two-staged when pumping into the intermediate service, this reducing their pumping capacity one-half. One of the accompanying photographs shows the interior of this station.

All the mains—two 24-inch, 28-inch and two 30-inch—extend west and southwest about two miles before they reach any material part of the distribution system.

The 30-inch main of the low-service system connects with both bays of the low-service reservoir, shown in one of the photographs. This is located at Ninth avenue and Pine street, in the southern part of the city, is of concrete in two sections, mainly in solid rock excavation and has an area of 2.6 acres and capacity of 15,000,000 gallons. The 24-inch main of the intermediate service (a branch of the 30-inch supply main of this service) is connected with each bay of the reservoir thru 8-inch pressure regulating valves, which discharge when the pressure in that main is 10 pounds above normal. The water surface in the reservoir is at elevation 2,114, about 220 feet above the central part of the city. In the far northwest part of the service district is the Audubon standpipe of concrete with overflow into a near-by sewer.

There are five of these standpipes, each 30 feet in diameter and 70 feet high and of 370,000 gallons capacity. Two of them are connected with the intermediate distribution systems. The Kenwood standpipe of concrete at Cincinnati street and Queen avenue, is in the extreme northern part of the city and is the regulator for the small northern intermediate pressure district. Its water line is at elevation 2,144. The Cook Hill standpipe, of riveted steel, at Grand boulevard and Fourteenth avenue, near the low-service reser-



SPOKANE WATER WORKS. *View of new municipal electric pumping plant. This plant operates alongside an older municipal water power pumping plant and purchases electric current from a company operating a large hydro-electric power plant.*

voir, serves the southern intermediate district. Its water line is at elevation 2,287.

The Twenty-ninth avenue standpipe, of riveted steel, at the corner of Scott street, in the extreme south end of the city, serves the high-pressure district at the water line elevation of 2,441 feet. This high-service district is supplied with water by the high-service pumping station located at the Cook Hill standpipe. Two 500,000-gallon pumps run by electricity lift water 8 feet from a small concrete well fed by the 14-inch line leading to the standpipe and pump it into the high-service system of distribution at a pressure of 103 pounds.

There is also the old Cannon Hill standpipe built in 1898, which is kept full with water line at elevation 2,217 and is ordinarily shut off from the distribution system.

There are two small pumping stations built in 1900 and 1903 for the purpose of taking water from the low-service distribution system and raising it to the intermediate system. These are now held in reserve and are not in regular use, especially in view of the construction of the new reservoir at Ray street and Twenty-fourth avenue on one of the branches of the new 30-inch supply main for the intermediate system.

The low service supplies most of the city, including the business and manufacturing sections and large residence sections at elevations from 1,780 to 2,050. The intermediate service supplies sparsely settled to moderately well built up sections between elevations 2,000 and 2,250. The high service supplies a small residential section which has elevations as high as 2,384 feet above sea level.

The engineers of the National Board of Fire Underwriters recommend a high-pressure fire-main system in the business section separate from the low-pressure distribution system, but connected with a supply main of the intermediate service so that it will have the pressure due to the higher elevation of its regulating reservoir and standpipes.

The city is improving the distribution by the addition of some cross lines of larger sizes than the ordinary street distribution mains so that pressures and deliveries at times of draft for fires will be equalized and improved and the underwriters have less than the usual number of recommendations of improvements of this sort.

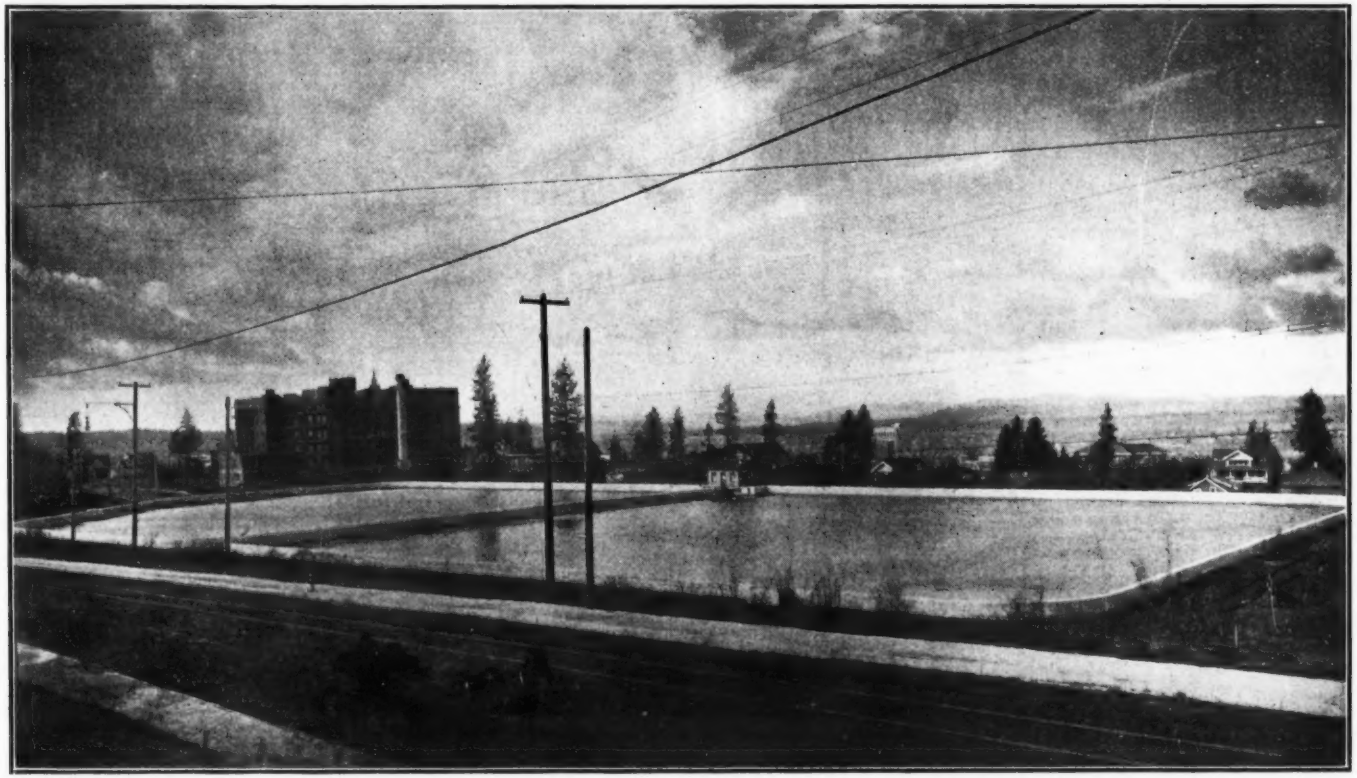
## Power Generation and Transmission at San Francisco Exposition

More than a dozen large firms have contracted for space in the Panama-Pacific International Exposition at San Francisco in 1915 in which to install engines built on the Diesel principle. These exhibits will occupy a central space in the great Palace of Machinery, and will be under operation thru connection with electric generators or other machinery for the purpose of showing the efficiency and economy of working. This ingenious motor is adapted now to railway traction. The engine, which uses crude petroleum as a fuel, has shown marked superiority in economy of operation over any form of steam-driven engine on board ships, particularly those running on routes where a supply of petroleum is available.

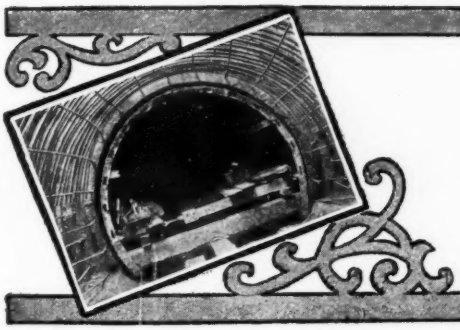
A large amount of exhibit space in the Palace of Machinery has also been spoken for by the manufacturers of steam turbines and unit type plants, the latter consisting of compact boiler, superheaters and engines. In the electrical department will be demonstrated the latest apparatus for the transmission and control of electric currents amounting to 1,000,000 volts or more.

## Ornamental Lighting for Alhambra, Cal.

The city of Alhambra, Cal., installed about six miles of ornamental lighting last year. The post used was designed by R. H. Blacklidge, city engineer, and is shown in the accompanying photograph.



SPOKANE WATER WORKS. *The low-service reservoir supplying the lower sections of the city, including the main business and residence sections. Of concrete, with two bays and supplied by pumps at the river above the city.*



# SANITATION

## Pollution of Scioto River at Columbus, O.

The report of C. B. Hoover, the chemist in charge of the division of sewage disposal at Columbus, O., for 1913, makes it evident that the sewage disposal plant now in operation treats only part of the polluting matter tributary to the stream, so that while the average discharge from the filters "probably would have been sufficient to prevent offensive conditions in an unpolluted stream" with the large flow of sewage in August, 20,990,000 gallons a day maximum and 18,400,000 gallans mean, and the low average flow in the river, probably less than 50,000,000 gallons a day, the condition of the stream was far from satisfactory.

The year was a very troublesome one. Heavy rainfall in the first four months was followed by low water for six months and heavy rainfall in November resulting in stages above normal in the river for the last two months. March was memorable for the heaviest rainfall and greatest flood the Scioto river has ever known, but the sewage purification plant was so well protected by levees that the damage to it amounted to a very few hundred dollars. The plant was not in operation so that there was no inconvenience on that score. The plant was shut down in October, 1912, and was not again put in operation until the middle of May, 1913. One of the accompanying photographs shows a flood which occurred during the construction of the plant and before it was wholly surrounded by levees. The 1913 flood reached nearly to the top of the levees shown.

Lack of funds and the greater dilution and less nuisance with discharge of raw sewage into the river during the winter months are assumed by the municipal authorities to be sufficient reasons for stopping the operation of the plant in cold weather.

The east side pumping station lifts the sewage from the eastern district over a divide into a branch of the main system. It was in operation in January and February not at all, but one day in March, 3½ days in April, all but one to 4 or 5 days in

FLOOD IN SCIOTO RIVER *before completion of works and protecting levee. Latest flood approached top of finished levee in background.*

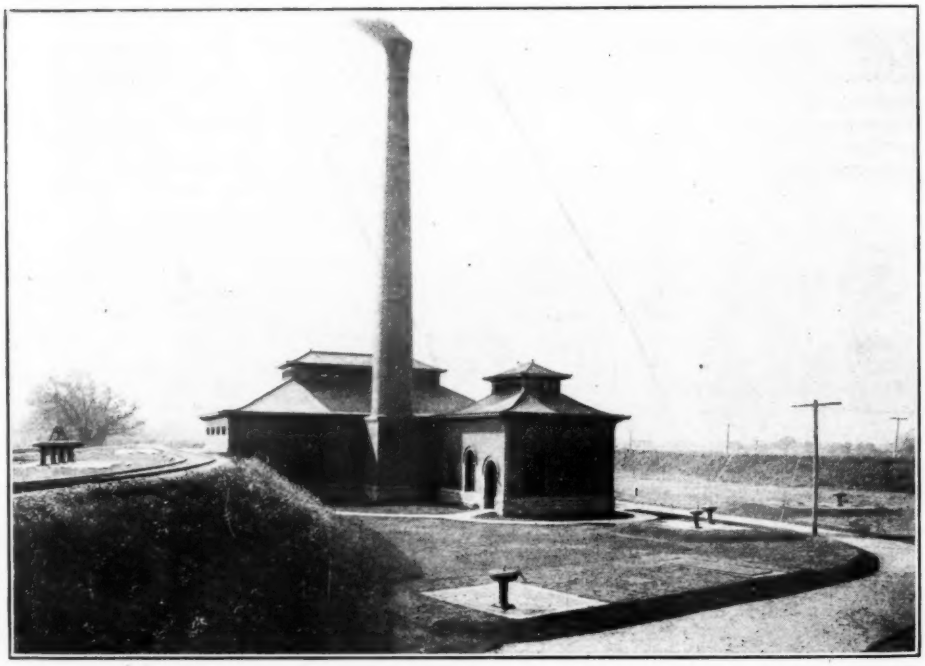
EAST SIDE PUMPING STATION *of Columbus sewage disposal. Electric power pumps.*

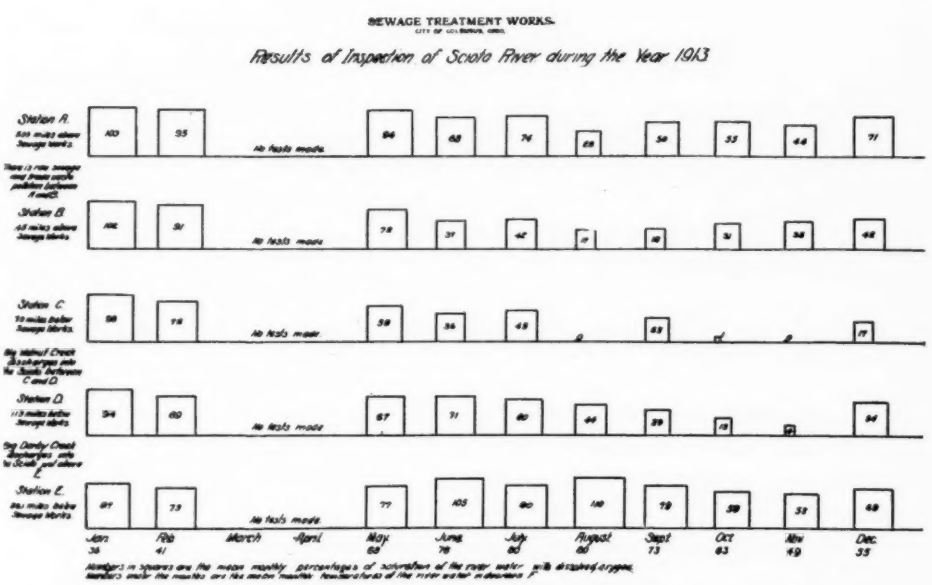
each month from May to October; 16 days in November and 14½ days in December. The rest of the time the sewage ran into the river directly at a point opposite the main pumping station. On account of insufficient pumping equipment at the east side station more or less sewage discharged into the river thru this relief outlet practically every day in the year, causing material pollution of the river by this raw and concentrated sewage.

The waste liquors from a large meat packing establishment are discharged into the river a short distance away and are probably much more responsible for the offensive conditions in the river than the effluent from the sewage treatment plant.

There are some 25 points at which the storm sewers overflow into the river, the sewage at ordinary times running into the intercepter and finding its way, with the above leakages, into the sewage tanks. When the storm water is above a certain volume the sewage overflows with the storm water, but diluted by it, directly into the river. When the connection of the sewer with the intercepter is clogged the sewage overflows directly into the river. This occurred in August in a sewer lo-

MAIN PUMPING STATION *of Columbus sewage disposal. A steam pumping plant.*






cated about 600 feet above sampling station A of the accompanying diagram, continuing for about 3 weeks until the obstruction could be all removed. This accounts for the high pollution shown in the diagram for August as compared with other months.

The main pumping station has the duty of raising all the sewage of the city some 18 feet into the outlet sewer connecting with the sewage disposal plant below the city, and of pumping out drainage water from the low west side when the water in the river is high enough to interfere with its drainage. It was in operation in January pumping west side drainage whenever the river was high, in February one day, March four days and April every day, pumping west side drainage; in May 15 days pumping west side drainage and 15 days pumping the city sewage into the outlet sewer; in June all the month taking west side sewage and as much from the east side as the pumps could take; in July all the month except 2½ days for repairs to steam lines and 2½ days in July and 2 in August because the apparatus for lifting sand out of the sand catcher was broken and there was no by-pass; in August all the month except as above; in September, October and November continuously but with reduced pumpage frequently because of numerous excessive storm flows in the sewer; in December continuously but with reduced pumpage because of shortage in operating funds. When the station is not in operation the raw sewage flows directly into the river.

After the first of May there was no day when a scouring velocity prevailed in the river and for much of the time there was nearly minimum flow. As a consequence the deposits in the river increased rather than diminished and the stream was seriously polluted thruout the year. Foul odors, gasification and floating sludge were present at times in the river from the relief outlet of the east side sewer to a distance of about 15 miles below the outlet of the sewage disposal plant. Wherever gasification was noted sludge deposits were found. No odors were detected where there was any residual dissolved oxygen, but absence of oxygen was not always accompanied by odors.

The zone of objectionable pollution is determined by the dilution, the oxygen requirements of the liquor discharged into the stream and the temperature. The percentage of saturation of the river water with dissolved oxygen was determined once each week during May to the middle of October and once each other month except March and April, following the great flood, at five points. The average results for each month are shown graphically in the accompanying chart, the figures in the squares noting the average percentages of saturation of the samples taken during each month as stated.

Mr. Hoover states in his report that if sufficient funds are supplied, the pollution from raw sewage can be very materially reduced and that the first and most pressing duty of the city is the prevention of the pollution from trade wastes and raw sewage above the disposal plant. He suggests again the desirability of installing improved treatment facilities at the sewage disposal works, on which he promises a special report.

Columbus is a growing city and it has

been obliged to spend vast sums of money in public improvements, and has still larger expenditures in view for flood protection and flood prevention, but it can hardly afford to skimp its sewage purification funds and must apparently increase, rather than decrease, its expenditures on this account if it is to keep its sanitary facilities equal to its material growth.

## A German Garbage Collection and Incineration Plant

Furth, a Bavarian city of 70,000 population, a suburb of the city of Nuremberg, has had in operation for more than two years a municipal garbage incineration plant that is regarded as a model of its kind and which, in connection with a modern system of garbage collection, makes the disposal of garbage of that city not only the least offensive and most sanitary possible, but also a matter of actual, although small, profit to the municipality, according to the report of the U. S. Consut at Nuremberg. Other German cities have excellent garbage incineration plants and still more almost ideal systems of collecting the garbage, but Furth is unique in that it combines the two and that both are models of their kind.

The garbage incineration plant occupies an oblong building 50 by 20 meters (164 by 65.3 ft.) ground plan and is located on the outskirts of the city, on the same premises with the municipal gas works. The building contains the boiler plant of the gas works as well as the incineration furnace.

Prior to February, 1911, Furth disposed of its garbage by depositing in receptacles of all descriptions, mostly uncovered, placed in front of the houses for the collection wagons, which were simple carts with lids, not preventing the dissemination of dust and stench in loading and unloading or even in transportation to the dumping ground, which lay in the vicinity of dwellings, into which dust and stenches were continually blown, and was, in spite of police prohibition, visited by small children and that class of people who always search garbage heaps for scraps.

The city magistrates on November 24, 1910, passed an ordinance requiring all persons living within the garbage-removal district to put household and kitchen waste, sweepings, ashes, and similar malterials (excepting tin, wire and metal scraps, glass, porcelain and clay vessels) in cans to be provided by the municipal incineration plant. The single-can system was adopted—one can for each house—and a can of such limited dimensions that the public would not be tempted to throw old shoes, dilapidated hats and broken pots in same vessel with garbage proper.

Each household must use the can furnished by the city. It is made of sheet iron with a heavy coating of zinc and has a capacity of 33 liters (8.7 gallons). The cans are solidly made, have a flat sliding lid fastened with a bolt and can be conveniently piled on top of each other. The cans are known as the "Ochsner system."

The wagons consist of a long truck on which rest 4 box segments divided into 2 compartments and opened at the top by sliding lids. There are 8 such lids on each side of the wagon. The garbage can is placed top downward on one of these lids in such a way that a device in the can lid catches on a rod extending along the edge of the segment box. This movement pushes back the lid of the wagon and opens the can, for the can lid remains attached to the rod. The garbage falls unseen, without dissemination of odor or dust, into the wagon. Each segment box has a capacity of 1.7 cubic meters (2.2 cu. yd.), consequently that of the wagon is 6.8 cubic meters (8.9 cu. yd.). The average weight of the garbage in each wagon is 2,550 kilos (5,621.8 lbs.), The sliding lids on the boxes are 1.45 meters (4¾ ft.) above the ground, permitting the collector to stand conveniently on the pavement and empty the cans. These boxes are removed from the wagon truck one at a time by an electric crane and placed on top of the furnace, into which the the contents go upon opening a spring valve in the bottom.

¶ GARBAGE WAGONS *are more than usually sanitary and odorless during collection.*

The garbage wagons are so constructed that they may be driven by horses or mechanical power. Experience has proven the latter to be 36 per cent. cheaper than the former. The wagons, therefore, are ordinarily coupled to an electric automobile having two large driving wheels in front and two smaller wheels in the rear, which are hoisted about a foot above the ground when the automobile is attached to the wagon and lowered only when it is detached. The axle motors (Braun syssystem) have an efficiency of 5.15 horsepower and are operated by storage batteries charged at the power house of the municipal electric works. They are divided into 42 cells and have a capacity of 390 ampere hours. The automobiles, when attached to the garbage wagons, attain a speed of 2 to 14 kilometers (1¼ to 8.7 miles) per hour, and when attached to the city supply wagons can reach 24 kilometers (14.9 miles) per hour. The

trucks of the garbage wagons rest on 2 pairs of wheels, making 3 pairs in all when the automobile is attached, and are so adjusted that both can be turned in a surprisingly small space.

After the city decided to burn its garbage it made a careful investigation, finally deciding on the Humboldt system used at Barmen. The one at Furth is about 16 feet in each dimension, and is divided into two chambers. Into these the two compartments of the garbage box are successively emptied after the latter has been hoisted from the truck by a crane and placed on top of the furnace. This is accomplished invisibly and there is no exhalation of any kind, because a system of mechanical draft creates a powerful suction.

The garbage thrown into the furnace comes in contact with the hot walls and the glowing slack and ignites in a few minutes. The furnace grates are divided into two parts—a principal grate and a front grate. Air is introduced thru numerous holes in the grates by a turbine draft. The garbage is first dumped onto the principal grate, where it burns at an average rate of 1 cubic meter (1.3 cu. yd.) in 15 to 30 minutes, the time depending on the amount of moisture in the garbage, and being longer in summer on account of the larger masses of vegetable waste. After the garbage is burned to a slack it is pulled with long hooks, operated by hand, onto the front grate, where it remains until the next wagon load is dumped into the furnace. It keeps the furnace warm and helps destroy the gases from the garbage being burned on the principal grate.

The gases are withdrawn into a separate chamber, where a temperature of 1,200 to 1,400 degrees C. destroys all organic and unwholesome materials, and where the floating ashes are segregated. They then pass to a boiler with a heating surface of 220 square meters (2,368 sq. ft.), which they touch on the front wall and then on the back wall, after passing beneath, thru pipes. The floating dust and ashes that still remain in the gases are precipitated under the boiler. The gases so purified now escape from chimneys 50 meters (164 ft.) high. The ashes that accumulate in the pipes and under the boiler are pumped out automatically by rotating pumps. The steam generated in the boiler is used primarily in the gas plant and what then remains is converted into electricity and used in the electrical plant.

The garbage is burned into a mass of slack, which is removed from the front grate into iron carts with long hooks operated by hand. The slack is cooled in water and then removed to a crusher, where it is pulverized. Hard substances, like pieces of metal, which were not decomposed in the heat of the furnace, are here separated. The ground slack is sifted into two piles, the one fine as gravel and the other about as coarse as chestnut coal. The ground slack has been pronounced by eminent authorities an excellent substitute for the gravel ordinarily used in mixing concrete.

THE TYPE OF GARBAGE WAGON USED, *but somewhat smaller than those described in the text.*

The distribution of the municipal garbage cans began in January and by the end of February, 1911, about 1,500 cans had been distributed. At the end of the year this number had increased to 16,017. About 85 per cent. of these were sold for cash at 3.75 marks (about 90 cents) per can, and the rest were paid for in 24

monthly instalments of 20 pfennigs (4¾ cts.) each. The old receptacles were used until the distribution of the new cans was effected.

¶ THE PLANT, *its equipment and results are shown in detail.*

The city began to remove its garbage in the new manner in the latter part of February, 1911, after the incineration plant went into operation. It had at its disposal 3 electric automobiles, 3 wagons, 1 supply wagon and 44 detachable garbage boxes. The total cost of installing this garbage-removal system was $10,888. Each wagon is accompanied by four to five men, who fill it in less than an hour. The electric automobile that hauls it to the incineration plant is immediately attached to a wagon that has been emptied in the meanwhile and returns to the place of collection. During the 11 months of operation in 1911, 1,873 collection trips were made, totaling 2,253 hours, i. e., each wagon was employed in collecting on an average of 1.2 hours per trip. During the same year a total of 10,517,000 pounds of garbage was collected. The total distance traveled by all the wagons was 8,456 miles. At the same time a smaller quantity was collected and transported in wagons drawn by horses, the average time taken by each wagon in this case being 1.46 hours. The amount of garbage brought to the plant in this latter manner amounted to 427,344 pounds, making a grand total of all garbage collected by means of horses and automobiles of 10,944,344 pounds.

On one day in the week in summer and on two days in the week in winter garbage is collected by horsepower, but only two segment boxes are used in this case, instead of the four used when the delivery is made by automobiles. The garbage collected in 1911 came from 2,255 properties, with a population of about 63,400. The whole business of collecting requires only 10 persons, namely, a foreman, a preparer, 4 collectors, 2 automobile drivers and 2 assistants. In winter an extra collector is employed.

The cost of collecting the garbage in 1911 was covered almost exclusively by fees taken from the property owners in the collection district. The amount of the fee is based on the rental value of the rooms from which the garbage is collected as ascertained in the tax valuation. As a rule the rental value of all the rooms is taken into account, but certain exceptions aer made, as, for instance, when continuously for more than six months no garbage has been collected from certain parts of the building. The total sum derived from fees in 1911 was $9,044. The cost of administration during the same year amounted to about $595, and the cost of operating to nearly $5,236.

Before the furnace was installed it was calculated that the annual quantity of garbage to be collected in Furth would amount to 12,000 tons. This computation rested on statistics from other German cities, where the daily output of garbage is 1.1 pounds per capita. It was found, however, that the total amount actually collected at the end of the year was less than 5,000 tons. The average time spent daily in consuming the garbage was 11.7 hours, so that the furnace cooled in the meanwhile, causing considerable waste of time each morning to bring it to the normal temperature.

The furnace, as stated, is divided into two chambers and there is a supplementary chamber for burning coke. This was designed to supply steam for the gas works during the night, when the garbage furnace was not in operation, but it was soon found to be inefficient for the purpose, and will probably be converted into a garbage furnace. Each chamber in 1911 received 7,544 dumpings, each representing the contents of a segment box holding 1,400 to 1,500 pounds of garbage. The average time spent in burning each load was 24.6 minutes.

¶ THE STEAM *generated by the plant and the clinker produced are sources of revenue.*

The steam generated in the boiler is used mainly in the gas works and the remainder is converted into electricity. In 1911 nearly 6,540 cubic yards of water were turned into steam. It is the most important item in making the incineration plant a profitable undertaking. For 1911 the value of the steam generated was estimated at about $5,700 and the price received for the slag was only $714. The expenses of operation for the same year were: Salaries and wages, $2,451; use of water, $714; maintenance, $536; interest on loan, $762; depreciation, $1,785. The income from the value of steam and the sale of slag was $6,414, leaving a slight profit of $166.

The slag from the furnace presents slight commercial possibilities. It was first used to cover the old dumping ground and then employed in concrete structures on the premises. Several authorities have carefully tested it and pronounced it an excellent substitute for the gravel ordinarily employed in mixing concrete. In some of the strength tests of the former, concrete cubes made of slag showed a resistance of 175 kilos per square centi-

meter (2,489 lbs. per sq.). In the freezing tests, which lasted 21 days, the cubes were submitted to 25 alternate freezings and heatings, but at the end of this period their condition was unchanged. Other tests made were even more favorable, showing a resistance as high as 302 kilos per square centimeter. Inasmuch as the minimum resistance required of concrete pillars and foundations is only 80 to 100 kilos, the value of the slag is apparent.

Up to the present the city has sold the coarser grade of sifted slag for 4.50 marks per cubic meter ($0.824 per cu. yd.), but has used all the finer sort on the premises. It hopes in time to derive considerable profit from the sale of slag.

As already noted, the small garbage cans are not destined for the reception of scrap tin, old shoes, etc. These however, are also carted away in separate wagons free of charge, are sorted at the garbage plant and the scraps are sold, producing enough to pay for their removal.

## Sewage Disposal in England

In Birmingham the household wastes and street washings flow thru the same sewers. More than half the houses of the city are connected with sewers. The sewage is first run into settling tanks and then treated on biological filters. The sludge is treated biologically, rendered inodorous, and afterwards dried on drying beds. The first attempt to eliminate impurities from the sewage was made in 1859, when two precipitation tanks were built and several acres of land acquired for irrigation. The purification effected was not satisfactory. Several methods of chemical precipitation were subsequently tried, but in 1871 a committee reported adversely on these methods. Since then the tank capacity has been greatly increased and a much larger area acquired for irrigation. Street sweepings, garbage, and ashes are burned in incinerators.

In Wolverhampton, a city with a population of over 95,000, sinks and water-closets are connected with sewers. There are some 10,000 pan closets, which are emptied weekly and the contents, mixed with ashes, sold to farmers. Separate sewers are provided for street washings in about two-thirds of the borough. The sewage is subjected to precipitation with lime, followed by land filtration. The sludge is pressed and sold to farmers in winter and air-dried on land in summer. Septic treatment of sewage was tried, but was considered unsatisfactory.

In Worcester, population about 48,000, sinks and water closets are connected to the same sewers that carry off the street washings. Sewage is filtered thru gravel beds and then thru sand beds; sludge is used for raising lowland. Street sweepings are sold; house refuse deposited on vacant land.

In Walsall, population 92,000, household wastes and street washings flow into the same sewers. The sewage is treated biologically and the sludge is used for fertilizing. Street sweepings, etc., are tipped on vacant land.

In Dudley, population 52,000, separate sewers are provided for street washings. Sewage is disposed of in two ways: The larger portion is conveyed to a large estate six miles from the town and turned onto the land there; the remainder, which cannot be disposed of in this way, owing to difficulties of level, is taken by the Stour Valley Drainage Board to their farms and is paid for by the corporation.

In Coventry, population 115,000, sinks and water closets are connected with the city sewers. The newer parts of the city are sewered on the duplicate system. Sewage is treated in tanks and irrigation fields. Percolating filter beds will be constructed soon with a capacity of half the dry weather flow. The sludge is deposited in beds on the farm and used on the land; it is also given away to farmers. Sweepings, garbage, etc., are burned. At one time Coventry sewage was purified by chemical precipitation.

In the city of Bradford, population 288,000, household wastes and street washings are run into the same sewers. The sewage is purified by chemical precipitation. The sludge is filter pressed for the extraction of wool grease, the yearly value of grease recovered being about $250,000; part of the press cake is sold as manure at 74 cents a long ton, and part is used as fuel. The first method of sewage purification tried in Bradford was filtration thru peat. Later, lime precipitation followed by filtration thru coke was tried, but this method also failed. The street sweepings are tipped onto vacant land, and house garbage and ashes are part tipped and part burned.

In Halifax, population over 100,000, household wastes and street washings flow into the same sewer. The sewage is treated in precipitation tanks and bacterial filters (double contact beds and percolating filters). The sludge is pressed and carted away by farmers. Street sweepings, garbage and ashes are tipped onto vacant land.

The city of Leeds has a population of 445,000 and maintains five sewage works. Household wastes and street washings flow into the same sewers. The sewage is subjected. to bacteriological treatment after chemical precipitation, and the sludge is pressed into cakes and disposed of as fertilizer. Sixty per cent. of the house garbage and ashes collected in the city is disposed of in destructors; the remaining 40 per cent is deposited on land

as manure or is used to fill quarries. The street sweepings are sold at 18 cents a ton to farmers and market gardeners. For ten years the city has experimented with practically all the known methods of treating sewage.

In Wakefield, a town of 51,000 inhabitants, located nine miles from Leeds, the household wastes and street washings are run into the same sewers, altho there are a number of special storm sewers to take away surface waters from the streets. The sewage is subjected to chemical precipitation, percolation thru bacteria beds, and settlement in humus tanks. The sludge is trenched into land formerly used for filtration purposes. At one time land filtration after chemical precipitation was tried, but the land proved unsuitable.

Nine-tenths of the sewage of Liverpool is discharged into the Mersey without treatment of any kind. The remaining one-tenth comprises the sewage of districts known as West Derby and Walton and is treated on the West Derby and Walton sewage farms, the system adopted being broad irrigation without chemical treatment, but assisted by bacterial and storm water beds. The West Derby farm has an area of 207 acres and receives the sewage of about 56,000 inhabitants. The Walton farm has an area of 183 acres and receives the sewage of about 61,800 inhabitants. The crops on both farms consist chiefly of rye grass, cabbages, potatoes, mangel-wurzels and beets.

In Salford, a town of 231,000, lying opposite Manchester, one system of sewers is used for both household wastes and street washings. The sewage is subjected to chemical precipitation, in which lime and salts of iron are used, and the tank effluent is then passed thru roughing filters and finally bacterial filters. The sludge is sent to sea in a 600-ton sludge steamer. Street sweepings are sold as manure, and the house garbage, ashes, etc., are burned in destructors. Many methods of sewage purification, probably twenty to thirty, have been tried in the last twenty-five to thirty years.

In Oldham, a town of more than 147,000 population all household wastes and street washings are carried off in the same sewers. The sewage is treated by precipitation, settlement and contact and sprinkling beds. The sludge is given to farmers. Street sweepings are used as manure, and garbage and ashes are burned in destructors.

Accrington, with a population of 50,000, has the single sewer system. The sewage is purified in septic tanks and by continuous filtration in percolating bacteria beds. The sludge is sent to the farming districts by canal. Street sweepings are sold as manure and the garbage and ashes are destroyed in destructors.

The single sewer system is also used in Stockport, population over 100,000. The sewage is subjected to chemical precipitation, land filtration and oxidation on bacteria beds. The sludge is pressed and disposed of to farmers. Street sweepings and ashes are at present tipped, but a destructor is in course of construction.

Leigh and Atherton, two towns with a combined population of over 66,000, have a single sewer system in common. The sewage is treated by means of chemical precipitation tanks, land and filters. The sludge is pressed and sold to farmers. Sweepings, garbage and ashes are burned in destructors or buried in tips.

In Rochdale, population over 91,000, household wastes and street washings are carried off in the same sewers. The sewage is subjected to sedimentation and bacterial treatment and the sludge is disposed of to local farmers. Street sweepings are sold to farmers and garbage and ashes are burned.

Until 1886 the sewage of Sheffield flowed in an untreated condition into the rivers and water courses. In that year a main sewage scheme was completed at a cost of $750,000, and sewage disposal works were constructed at a further cost of $220,000, the process adopted being that of lime precipitation. The works were designed to treat a flow of 10,000,000 gallons of sewage per day, but for several years a flow of 17,000,000 gallons has been dealt with, and since 1886 the population has increased from 304,720 to 470,000, and the introduction of the water carriage system, the extension of the drainage area and the increased requirements have necessitated improved methods of treatment in addition to increased capacity. It was finally decided after exhaustive experiments to adopt a scheme consisting of continuous flow settling tanks and contact beds. The local government has approved of the scheme which is now partly in operation, and the remainder is approaching completion.

The estimated cost of the extensions was $1,350,000, but it appears probable that the work will be completed for $35,000 less than that amount. In addition to this the city has bought lands for the present works and future extensions at a cost of $430,000.

The principal features of the scheme include a new main valve chamber, into which a 5-foot barrel sewer discharges, and also a 7-foot duplicate sewer. A storm water overflow arranged to discharge the excess flow above 64,500,000 gallons per day to a storm water conduit is fixed in the chamber.

A large penstock, with opening 5x12 feet, admits the sewage to a conduit 12 feet wide, which conveys it to the catch pits. Two pairs of catch pits, 42 feet long,

29 feet wide and 13 feet deep, have been constructed; they are fitted with new screens, which extend the whole length of the pits and which are cleaned by hand rakes. The catch pits are in the form of a double hopper and retain the heavier grit, garbage and larger objects. Each pair is fitted with endless chain bucket elevators for cleansing purposes. Two additional catch pits have been added, approximately twice the size of the older ones, and fitted with mechanical screens and an electrically driven traveling bucket dredger. The sewage passes from the catch pits thru branch and main conduits 12 feet, 16 feet and 20 feet wide, built in brick and covered with girders and concrete to the settling tanks. The complete scheme includes seventeen continuous flow settling tanks, each holding approximately 1,000,000 gallons, which are now in operation.

Sixty contact beds, each half an acre in area and sixteen storm beds of similar design but twice the size are in course of construction. The works will provide for the treatment of a maximum quantity of 64,500,000 gallons of sewage a day, and will be one of the largest of its kind.

Sheffield has two extensive garbage destructors, the refuse destroyed in 1912 and 1913 amounting to 42,898 and 33,805 tons, respectively, at a cost of $28,760 and $21,450. For dumping 35,663 tons of garbage requiring railway transportation there was expended, in addition to these amounts, $20,435.

A plant for converting fish refuse into fertilizer recovered 82½ tons during 1913; it was sold at a profit to the municipality of $600. There is also a can bundling plant that handles 300 to 400 tons of used cans a year.

## Sewer Construction at Watertown, New York

Wm. J. Semper, contractor, recently completed the construction of 9,500 lineal feet of sewer at Watertown, N. Y. Reinforced concrete pipe was used in different sizes from 27 inches to 36 inches in diameter. The soil consisted of sand at and near the surface, gradually changing to coarser sand mixed with a little gravel saturated with water at a depth of about 8 feet from the surface. The average depth of excavation was about 12 feet, the first 4 feet being excavated and left standing without shoring, this being possible on account of the compact character of the sand.

Wemlinger Corrugated Steel Sheet-Piling type 3-A, ⅛-inch thick, 10 feet long was used. The contractor purchased 400 sheets, which, owing to the fact that each sheet has an effective width of 12 inches including the overlap, allowed the shoring of 200 lineal feet of trench.

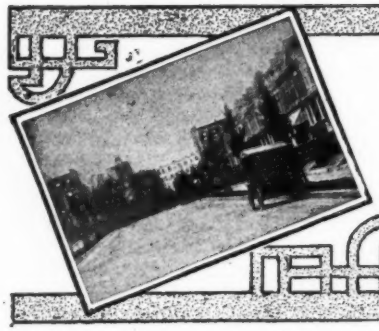
The sheets were ldiven 5 feet at a time. In other words, the hammer was operated over a section of trench forward until all the sheets in that section had been driven 5 feet. Then part of the trench was excavated further and the timberling lowered, after which the sheet-piling was driven another 5 feet, so that when the excavation was made to grade there remained a toe of 2 feet below the bottom of the excavation, which avoided the necessity of bracing the sheet-piling at the bottom.

After a sheet had been driven, the hammer was raised by means of a 1-ton triplex block mounted on a double-A frame spanning the trench. As soon as the hammer was in position on top of the next sheet to be driven, the block was unhooked and the hammer steadied by hand as shown in Fig. 1. This was found necessary because the sheets went down too fast for the block chain to follow. It was found that the time of driving the sheets 15 feet was from 33 to 40 seconds with the bottom of the sheet-piling 10 feet below the surface. In other words, the actual driving time for each full 10 feet was 1 to 1½ minutes. More time was consumed to shift the hammer than in the actual driving. It was found that it required an average of 2½ minutes to raise the hammer and place it in position for each 5 feet driven. Including the time of moving the driving rig comprising hammer and a frame for driving, it was found that 7 feet of ditch could be sheeted per hour for each 5 feet driven.

As stated before, there was enough sheeting on hand to shore 200 feet of trench. Inasmuch as some of the sheeting was being pulled and carried forward, it required three men to carry all the sheets a distance of about 175 feet. It required about 1½ hours for these men to carry 32 pieces and set up the same on each side of the trench thereby completing a 16-foot section.

No attempt was made to pull the sheet-piling until the sheeted trench had been back-filled to the top, which still left a depth of about 4 feet of bank unprotected, which, as previously explained, stood up without being shored.

With one man at the head of the sheets, whose duty it was to attach the clevises thereto, and two men operating the triplex blocks, seventy sheets 10 feet long were pulled per hour. In other words, for every hour that the three men worked on the pulling, they were able to withdraw all the sheet-piling required for 35 feet of trench. The wages of the men were $1.50 per 10-hour day each, and therefore the cost of pulling was less than 0.1 cent per square foot.



# ROADS AND PAVEMENTS

## The Importance of Highway Maintenance

*By Leonard S. Smith, M. Am. Soc. C. E., In Charge of Highway Engineering, University of Wisconsin, Madison, Wis.*

WE, in America, fail to understand that the main reason why our roads are so inferior to those of Europe is the general lack of an adequate system of maintenance. A century of experience has taught the European engineers and taxpayers that the time to begin the repair of a road is the day after its construction is finished. The European engineers when constructing a macadam road provide an extra supply of the same material regularly deposited at the side of the road at intervals of 50 to 100 meters. In America, however, we put off the repair of our roads until the day after they are worn out. As a result, while the European road surfaces are well maintained and long lived, the American roads are too often rough and short lived. This criticism, while generally true of country highways, is also, to a considerable extent, true of the city pavements. We know how to construct as good roads and pavements but we have yet to learn the need of their maintenance. This misconception of the significance of road maintenance is well illustrated in a current engineering magazine in which a road commissioner, after describing how well he has constructed an asphalt concrete road, "subject to the heaviest travel," says: "We feel that we will not be required to do anything in the way of repairs for eight or ten years." If such confidence were only justified.

It is the writer's experience that such a pavement is certain to show some weak spots after the first winter, if not, indeed, the same season. These defects, tho insignificant and easily and cheaply corrected at first, are soon enlarged by a heavy traffic to such an extent as to greatly impair the life of the pavement.

In no other construction does the old adage, "A stitch in time saves nine," apply more aptly than in road repair. This principle has been proved so many times in the history of road construction that the Europeans consider us very stupid indeed not to accept and act on it. This failure on our part to appreciate the function of maintenance as an important element in the economics of highway construction is unfortunately not confined to our humble country path masters but is shown by officials high in authority. This misunderstandng was well illustrated recently when the writer was urging upon a high official the importance of maintenance, but elicited only the reply, "Let us build the roads first." If the maintenance of roads must be delayed until our system is completed the greater part of such roads will be past all hope of repair.

It is well understood abroad that both the construction and maintenance of roads have a single object and that both are necessary to attain that object. It may well be that a better service will be afforded by a poorly constructed road, well maintained, than by a well constructed road without maintenance. At the present time taxpayers are showing much enthusiasm for the construction of hard surfaced highways, and it is important that this enthusiasm and interest in road building shall be fostered and encouraged. Can anyone doubt if the first pavements prove a disappointment, because of their short life, that the effect of such failure will tend to discourage further road building?

Where states or communities build roads or pavements out of the proceeds of the sale of bonds, there exists an additional reason for systematic and thoro maintenance of such roads. For even with good maintenance, there will usually be some difficulty in preserving the road for a term equal to the life of the bonds, and, lacking such maintenance, most highway construction will have worn out long before the bonds are paid. This has actually happened in some of our American states and municipalities.

There are many miles of expensive macadam roads in New York state, the life of which will be less than twenty years, all built out of the proceeds of bonds running fifty years. Such a system of financing good roads is both shortsighted and selfish, because we thereby transfer to the backs of our children the burdens which we of today should bear. It should be a matter of much pride to citizens of Wisconsin, that all state aid for road building is derived from current taxes alone. It does not require a prophet to see that tho the present road problems are indeed serious, those of the future are quite certain to be much more so. Again the failure to maintain the New York roads during the first few years succeeding their construction has resulted in an excessive cost of maintenance during the past three years of over $1,000 per mile per year. But New York state has learned from experience the lesson of continuous maintenance, and other cities may well profit by her example. During the year of 1912 the maintenance department on New York state highways employed 735 patrolmen, who cared for approximately 3,151 miles of completed highway. Each patrolman furnished a horse and cart, together with the necessary small tools. The work of maintenance under this patrol system consisted "in keeping the surface of the paved roadway in as nearly perfect condition as possible, keeping the dirt shoulders smooth and safe for travel; culverts and drainage system free from obstruction; woods, grass and brush cut within the limits of the highway and in making small repairs to structures and guard rail. In addition to these duties, the patrolmen filled the ruts and repaired small defects which appeared in the road as a result of heavy travel." The total amount of money spent by New York state in 1912 on maintenance and repair work amounted to nearly $3,000,000. Contrary to the common belief, paved roads there are not permanent structures.

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¶ CHANGES IN TRAFFIC *conditions are very rapid on newly improved roads and must be allowed for in making the plans.*

One reason for the general indifference in the United States toward this question of maintenance is found in the failure to visualize the future traffic. For example, the officials of one state highway commission took a traffic census several years ago on country highways and found only a light traffic; they therefore concluded that a construction suitable for such traffic was all that should be provided. As a matter of fact the building of a hard surfaced road at once disturbs the old equilibrium of traffic by attracting to the new road new traffic which formerly sought other routes.

This can best be illustrated by giving some statistics from a paper by Col. Sohier, chairman of the Massachusetts State Highway Commission, and presented by him at the convention of the American Road Builders' Association at Cincinnati. Briefly stated, he found the average daily traffic on one road, which in 1909 was 185 vehicles, had increased in 1912 to a daily average of 586 vehicles, an increase of 217 per cent. in three years. The increase of motor-driven vehicles was 200 per cent. and of heavy teams 288 per cent. On another road the average daily traffic increased from 81 vehicles in 1909 to 333 in 1912, or 300 per cent. In this case motor-driven vehicles comprised 42 per cent. of the traffic in 1909 and 75 in 1912. These examples are probably indicative, in general, of traffic changes in other states, tho, of course, not always with the same percentages. The point which here needs emphasis is, that if a dirt road requires little or no maintenance before its improvement, after such improvement the increase in traffic which it is certain to attract, will render some maintenance imperative. This has been repeatedly shown to be true in every eastern state, and it is high time that the western states profited by such experiences. The situation would only seem to require that the full facts relating to this experience should become widely known to our citizens.

To a student of highway economics, the alarming rate at which maintenance expenses increase, when any considerable amount of the state highways have been improved, is certain to cause apprehension, and should be of vital interest to the taxpayer.

Turning again to New York state, we take the following figures from the published report of the State Highway Department:

*Cost of Maintenance.*

| Year | Mileage. | Maintenance. | Cost per Mile. |
|---|---|---|---|
| 1907..... | 667 | $ 206,100 | $ 309 |
| 1908..... | 978 | 360,660 | 379 |
| 1909..... | 1,987 | 1,369,100 | 679 |
| 1910..... | 2,133 | 1,800,000 | 1,001 |
| 1911..... | 2,622 | 2,135,133 | 387 |
| 1912..... | 3,100 | 3,127,900 | 1,009 |
| 1913..... | 3,813 | 5,000,000 | 1,311 |
| Average ..... | | | $ 983 |

Heavy traction engines, fast moving automobiles, and heavily laden narrow steel-tired wagons are responsible for a very large part of this excessive cost of road maintenance. In all justice to the tax-

payer this class of vehicles should be made to contribute to the maintenance fund, their just share of such damage. This principle has long been recognized and acted on in Europe, and, to a lesser extent, also in some of our states. Most states exact an automobile license fee, but often not more than five dollars per year, an insignificant sum if intended to compensate for the wear of the roads. Instead of a flat sum it seems more fitting that the license fee should be made proportional to the weight and horsepower of the vehicle. In England a 45-h.p. touring car would be required to pay a license fee of about $100 per year. Such a tax has been justified, not only as a partial return for damage done to the road thru the use of the motor car, but also as coming from a class to whom such a tax would be far from a burden.

The following table showing the annual cost of road maintenance in Massachusetts is perhaps a safer guide because this work has been under a more continuous and expert management than in New York:

*The Cost of Maintenance of State Highways in Massachusetts.*

| Year. | Total Mileage. | Cost of Maintenance per mile of road. |
|---|---|---|
| 1905 | 548 | $105 |
| 1906 | 610 | 112 |
| 1907 | 655 | 162 |
| 1908 | 702 | 327 |
| 1909 | 740 | 543 |
| 1910 | 784.6 | 652 |
| 1911 | 828.6 | 647 |
| 1912 | 879.5 | 676 |

Another method of securing the funds for maintenance and one largely used in Europe, is the taxing of all gasoline used in motor cars. It has been estimated that a tax of six cents per gallon (the tax in England) would have produced a fund of $1,600,000 in New York state in 1912. Such a tax would have the advantage, also, of being proportional to the use of the roads. This method of taxation will be recommended to the next New York legislature by the state superintendent of highways, and would seem to deserve a wide adoption.

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¶ TRAFFIC REGULATION *is resorted to for the purpose of preventing excessive wear or extravagant cost of construction.*

But better still than paying for excessive wear to our roads is a system of state legislation designed to prevent such wear. Several eastern states have already enacted such legislation. Some of the provisions of the New York law include the following: (a) Traction engines are prohibited from traveling over improved highways for threshing purposes after January 1 1914, and, in the meantime, such engineer must pay for any damages. (b) The tires of each wheel of any steam roller, automobile truck motor, or other vehicle shall be smooth, and the weight of such vehicle, including load, shall not exceed 800 pounds upon any inch in width of the tire, wheel or roller. (c) No motor or other power vehicle shall have a greater width than 90 inches except traction engines 100 inches. (d) No traction engine, steam roller, automobile truck or motor carrying a weight in excess of 4 tons, including the vehicle, shall be operated at a speed of greater than 15 miles per hour and no vehicle carrying a weight in excess of 6 tons including the vehicle, shall be operated upon any state highway at a speed greater than 6 miles per hour, when equipped with iron or steel tires nor greater than 12 miles if equipped with tires of hard rubber.

With a force of over 700 patrolmen evenly distributed over the state highways, and assisted by the other regularly constituted peace officers of the state, it would seem entirely feasible to enforce the above laws and regulations. There can be no doubt that such enforcement will go very far toward preventing the present excessive wear on improved roads. Neither European nor American roads have been built to withstand the present traffic demands, especially the fast moving auto and heavy motor truck. Even the expenditure of $45,000,000 per year on the widely heralded French highways has not prevented these water-bound roads from wearing rough where subjected to excessive motor traffic. The general substitution of the motor vehicle for the horse-drawn vehicle, while greatly reducing the maintenance cost of city pavements built of wood, stone, brick or asphalt, has had exactly the opposite effect upon country highways built generally of some form of broken stone or gravel.

In the judgment of our most experienced engineers, the road of the future, designed for heavy fast moving traffic, will make use of our immensely valuable broken stone and gravel resources in a permanent concrete foundation, provided with some comparatively thin and easily replaced wearing surface. If such wearing surface be made of some kind of bituminous material which could be remelted and laid again, the maintenance costs involved would seem to be a minimum. In a large part of the Mississippi valley the use of vitrified brick on a concrete base is becoming deservedly popular because of its long life and resulting uni-

formly low costs of maintenance. At the present time numerous American road officials are experimenting with various mixtures of concrete for both foundation and wearing surface. The reports on these experimental pavements are very conflicting except on one point, viz: That concrete roads have not been able to withstand the abrasive action of heavy steel tired vehicles, tho well suited for motor traffic.

The writer disclaims any partiality toward foreign practice of road making. In fact, except for their superior system of road maintenance, his investigations fail to show any superior knowledge on road administration over that possessed by American engineers. Indeed, so far as the theory and practice of asphaltic materials for road purposes is concerned, European engineers frankly confessed that they looked to America for the correct solution of present problems.

Again, in making any comparisons of highway conditions in America and abroad, due allowance should be made for the fact that European road systems have taken a century for their construction; in fact, many of their main roads were first built by the Romans over 1,500 years ago. Moreover, this great work was first initiated, and in very large part supported by an ever-present military necessity.

In America, the good road movement is scarcely fifteen years old. In this brief experience we have learned how to make our standard roads as well suited to our comparatively thinly settled country and the attendant traffic conditions as the French roads are suited for French conditions. One might go further and say that no county in England has a system of roads so permanently constructed as the 1,700 miles of brick pavements in Cuyahoga county, Ohio. It is not the construction, but in the maintenance of our roads that we need to copy from Europe. When will we learn that pavements are not permanent structures, but instead require constant repair and maintenance? We will be very stupid, indeed, if we do not accept and take advantage of the experience of Europe and our own eastern states. The highest efficiency and continuity of management will be promoted by placing the maintenance of all state or main trunk roads in the hands of the state highway departments, out of the influence of petty county politicians.

Most significant to highway engineers and most encouraging to the taxpayer is the present well founded confidence in and reliance on scientific methods, both in the selection of road materials and in their incorporation into the completed road. But only after our people are equally well converted to scientific maintenance can we realize our ambition for good roads.

*March, 1914*

## Brick Pavements in Baltimore, Md.

In its new work the paving commission of Baltimore has made quite an important place for brick paving, recommending it particularly for medium traffic business streets and for streets and alleys less than 30 feet wide.

The average cost of vitrified block paving with cement filler on 4-inch concrete base is about $1.92, and on 6-inch concrete is $2.14.

The specifications used are practically those of the American Society of Municipal Improvements and are restricted to cement filler. Wire-cut-lug blocks are popular, having been introduced but a few months since.

At the begining of last year the city had 30.69 miles of vitrified block pavements in streets and 3.96 miles in alleys, a total of 34.65 miles, or 654,828 square yards. In mileage brick is exceeded only by granite block, and the cobblestone which is being so rapidly replaced, and amounted at that time to 334 miles. In yardage brick is exceeded only by sheet asphalt and granite block. In 1912 about 20,000 square yards of brick pavement was constructed.

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## Method of Constructing Concrete Pavement

*By Paul E. Kressly, C. E., City Engineer, Inglewood, Cal.*

WHILE hydraulic concrete pavement is to be recommended only for country roads and for city streets of moderate travel, it may, however, be interesting to engineers engaged in the construction of highways to bring to their attention the durability and serviceability of this type of pavement which the author of this article designed and constructed for the city of Nazareth, Pa., during the summer of 1908.

While our experience with this kind of pavement is yet limited, there is reason to believe from the nature of the material that it will not prove to be a satisfactory or economical pavement for streets of heavy travel, unless the surface is protected by a bituminous macadam wearing surface of such a character as will protect the concrete and resist the abrasive stress of travel. Such a pavement undoubtedly would satisfy the following conditions:

1. Low in first cost.
2. It would be durable, i. e., the cost of perpetually maintaining its surface in good condition would be comparatively small.
3. It would have a smooth surface; however it would possess only a medium hard surface, and therefore the tractive

resistance would be slightly greater than that of some other types of pavement surfaces.

4. It would offer a good foothold to enable horses to draw heavy loads, and prevent them from slipping or falling.
5. It would be comparatively noiseless.
6. It would be easily cleaned.
7. It would be practically impervious, and can therefore be kept in good sanitary condition.
8. It would yield neither mud nor dust.
9. It would be comfortable to those who ride over it.
10. It would absorb more heat than some other types of pavement; however, this would not be excessive, as to make it very objectionable.

Taking into consideration all the conditions that a hydraulic concrete base with a bituminous macadam wearing surface fulfills, it is safe to state that this kind of pavement approximates the perfect ideal for country highways or city streets with light traffic where a permanent pavement is wanted and warranted. For these it is believed that a properly constructed pavement of this type will prove very satisfactory and durable, and the low cost at which it can be constructed should make it very attractive to city officials or those interested in the construction of state and county highways. Like other composite pavements, its utility and durability will depend largely upon the good quality of the materials used and the skill and thoroness with which the work is done.

Getting back to the hydraulic concrete pavement constructed at Nazareth, Pa. I want to describe the methods of designing and construction employed, the cost, wearing qualities and other important data relating to this type of pavement. As stated before, this pavement was constructed under the supervision of the author in the summer of 1908. As to the results of the wearing qualities, I am indebted to Mr. Frank P. Stirk, C. E., who was the engineer in charge of the construction work, and who has made frequent observations of this particular pavement described, and reported to me in November, 1913, that the same has given very satisfactory results up to that date. The pavement has therefore been in use for a little more than five years, and has fully demonstrated its usefulness. The life of the pavement is problematical, but it is safe to state that if the concrete were protected by a bituminous macadam wearing surface its life and usefulness would be inestimable.

The design, specifications, methods of construction, etc., will be described in the following order:

Hydraulic Concrete Pavement Surface—13,625 square yards.

Grades—The length of the street paved was six blocks, approximately 3,600 feet in length and 35 feet in width between curbs; the grade for five blocks was 0.4 per cent., and one block a grade of 3.9 per cent.

Cross-Section of Roadway—A parabolic crown was used, in which the amount of crown was equal to 1/120 of the width of the roadway, or approximately 3½ inches. This coefficient of roadway crown was used to reduce the lateral slope of the roadway, thereby reducing the probability of horses slipping and which would at the same time effectively drain the roadway surface.

Subgrade—The character of the soil was clay loam, underlying which at an average depth of three feet was a stratum of limestone rock. The excavation to the surface of the subgrade had an average depth of eight inches, which was loosened with a plow and loaded on wagons by hand shoveling. The surface was dressed with pick and shovel, after which it was sprinkled and thoroly rolled with a twelve-ton steam roller, which was passed over the surface successively, until the subgrade was consolidated and uniformly hard and firm. The subgrade was eight inches below the finished surface of the pavement, and parallel thereto.

Concrete Base—Thickness, 5½ inches; proportions of concrete, 1:3:6.

Cement—Portland. Three kinds were used; namely, Phoenix, Dexter and Nazareth; each kind being manufactured by different firms within the city limits of Narazeth. Two blocks were constructed with each brand. The cement was required to meet the tests recommended by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

Sand—To be composed of grains not softer than hard limestone. It shall be moderately coarse and preferably made up of grains of varying size producing a mass with low percentage of voids. It shall not contain, in all, more than 5 per cent. by volume of clay, loam, mica scales, silt or other objectionable inorganic matter, nor more than 1 per cent of organic matter.

Broken Stone—It shall be of hard and sound limestone, broken to a roughly cubical form. It shall be screened thru efficient revolving screens, and only such fragments as have passed thru circular screen opening 2½ inches in diameter shall be used. If the crushed dust and fine fragments be not screened out, the stone must be so handled that the fine material will be evenly distributed thru the mass when it reaches the mixer.

Water—Water used for concrete shall be fresh and reasonably clean.

Care and Handling of Concrete Mate-

rials—Cement was placed on a platform which was at least six inches from the ground. It was never allowed to become wet or damp. Sand and stone delivered on the work was stored on lumber floors, as this avoided taking up earth and mud with materials, particularly when the street was wet or muddy, so that there was no fear of injuring the concrete. The stone was thoroly wet a sufficient time before being placed in the concrete, to allow any surplus water to drain away; however, remaining moist when it reached the mixer.

Mixing Concrete—A machine batch mixer was used on the work, and the time allowed for mixing was never less than about two minutes, averaging three minutes, so that the mortar was evenly distributed thru the mass and every fragment of stone was well coated with mortar, sufficient additional water being added as the mixing progressed to produce a rather wet, but not sloppy, concrete.

Placing the Concrete—It was delivered from the machine directly into barrows, and in such a manner as to prevent, as far as possible, the separation of the mortar from the stone. It was evenly distributed in a single horizontal layer of such depth that, after ramming, it was 5½ inches in thickness.

Wearing Surface Course—Thickness, 2½ inches; proportion, 1:1½:3½.

Cement—Requirements same as in base.

Sand—The sand as specified in sand for base, except that it shall be especially clean, and the grains of such size that at least 75 per cent. of the mass will fail to pass a screen having thirty meshes to the linear inch, and shall be of a superior quality.

Crushed Rock—The rock similar in quality to that used in the base, with the exception that it shall be crushed to such sizes that all will pass thru a screen having meshes 1¼ inch square and that none will pass thru a screen having meshes ½ inch square, and it shall be free from clay, refuse or other foreign substances.

Mixing Concrete—Same methods employed as the base mixing, with the exception that the cement and sand were thoroly mixed together dry, enough clean water was then added to make a rather wet mortar and the mixing continued until the materials were thoroly incorporated into a homogeneous mass. The crushed rock was then added and the mixing continued until every fragment of stone was completely covered with mortar. Care was taken in handling and adding the stone to the mortar to prevent the stone segregating into masses of different sizes. Sufficient water was then added during the mixing, whenever necessary to make what is termed a "wet" concrete.

Placing the Concrete—The concrete thus prepared was placed upon the base course before the latter had begun to set. This requirement was strictly enforced. Otherwise, there would have been danger of the two courses not properly adhering to each other. The concrete thus placed was well rammed and carefully graded by means of a templet, the surface of which conformed to the finished surface of the pavement.

Rolling—The surface was then rolled with a five-ton power roller of the asphalt type. All these operations were completed before any of the concrete in either course had begun to set. The purpose of this rolling was mainly to evenly compress the mass and thus secure its uniform density. It also produces a truer surface than can usually be secured by any other method. At the termination of the day's work the concrete was always continued to an expansion joint.

Protection of Concrete—For a period of ten days, and frequently longer, if conditions made a longer time necessary, the concrete was kept in a moist condition thruout by sprinkling. No travel was allowed on the street for a period of fourteen days.

Expansion Joints—These were placed along the curbing on each side of the roadway, and on account of there being an electric railway track in the center of the street, an expansion joint was placed approximately 2 feet 3 inches outside of each rail, and running parallel thereto. Longitudinally they were placed 25 feet apart. The roadway, as stated before, being 35 feet in width between curbs, this arrangement of the expansion joints made the size of the blocks approximately 13 feet by 25 feet, and 8 inches in thickness. The joints were made ¼ inch in thickness, cutting entirely thru both courses of concrete along a straight line. They were made by the use of a ¼-inch-thick steel plate, the shape conforming to the crown of the street, and were placed in position before the concrete was deposited and removed just before the same had begun to set; after which the joint was smoothed with a T-shaped smoother, and of the same thickness as the steel plate. The smoother was worked back and forth in the joint until the edge of the concrete adjoining the joint was thoroly and smoothly compacted, having a radius of about ¼ inch.

Filling the Expansion Joints—The filling of the joints was made with bituminous cement composed of coal tar pitch, to which was added 20 per cent. of refined Trinidad asphalt and 20 per cent. of hydraulic cement, all by weight. The pitch was first melted, and also the asphalt, which was added to the pitch and thoroly incorporated by agitation. The hydraulic cement was then added and the whole

agitated until a complete and uniform mixture was obtained. The cement was poured into the joints while still hot, until they appeared to be nearly or quite full. After allowing time for the filling to subside, the joints were gone over a second time and completely filled.

Among engineers there is quite a wide difference of opinion as to the necessity for expansion joints and also as to the proper spacing. Some suggest that it would be better to omit them entirely, allowing the pavement to form its own expansion joints by cracking along lines where the natural forces dictate. Such cracks by their irregularity give a bad appearance to the surface, and it appears to me that it is not a very good practice to follow.

Cost of Work and Organization—This work was constructed by day labor under my supervision, the construction work being in direct charge of one of my assistant engineers. The organization consisted of:

| | |
|---|---|
| Construction engineer, per day | $6.00 |
| Two foremen, each per day | 4.00 |
| Two experienced concrete men, each per day | 3.50 |
| Machineman, per day | 3.00 |
| Rollerman, per day | 3.00 |
| An average of 28 laborers (Italian), each per day | 1.50 |

Ten hours constituted a day's work.

Summary of cost of pavement per square yard:

| | Per Sq. Yd. |
|---|---|
| Excavation | $0.086 |
| Preparing subgrade | .023 |
| Concrete base, 5½ in. thick, 1:3:6, material | .490 |
| Wearing surface, 2½ in. thick, 1:1½:3½, material | .250 |
| Mixing, placing, ramming, etc., including foreman | .186 |
| Rolling wearing surface and keeping concrete moist for ten days | .012 |
| Expansion joints, averaged per square yard | .034 |
| Incidental expenses | .015 |
| Engineering | .071 |
| Total cost per square yard | $1.167 |
| Cost of cement delivered on the work, per barrel | $1.30 |
| Sand delivered on the work, per cubic yard | 1.05 |
| Crushed rock delivered on the work, per cubic yard | 1.20 |

All the material required was close at hand.

Efficiency and Serviceability of Pavement—As stated before, I have not personally seen this pavement for over three years; however, according to the report furnished me, the surface is in excellent condition. There are a few transverse hair-line cracks in several blocks. Between the rails of the track, also between the rails and expansion joints, there are a few cracks, but they are not very prominent. The opening of the cracks does not exceed 3/16 of an inch. The cracking, no doubt, is attributed to the continual jarring of the heavy interurban cars. No repairs were required to date on any part of the work. The maintenance costs thus far were confined to cleaning only. The amount of wear, as close as could be ascertained, amounts to ⅜ of an inch, or slightly in excess of 1/16 of an inch per year.

In addition, I may state that the pavement is subjected to a heavy teaming traffic; the amount at this time I am unable to give, but after the street was completed I feared for the safety of horses on the 3.9 per cent. grade; and the three cement companies, previously mentioned, being interested in the success of this type of pavement, suggested to place a man on duty for a period of ten days, from 6 a. m. to 7 p. m., and take a census of the traffic, and also observe the number of horses slipping or falling on this grade. The results were very gratifying, as follows:

Number of vehicles passed in one day, including pleasure vehicles, automobiles, delivery wagons, heavy teams, etc., average per day for the ten days, 461, of which number 63 per cent. were heavy teams.

Horses slipped, seven in ten days.

Horses fell on knees (slipped on rail), one in ten days; fall on haunches, none; complete fall, none.

Accidents of any kind, none.

It may be interesting to note that, while these observations of traffic were taken, there were two rainy days, and the horses that slipped and the one that fell on the knees did so on the days that it was raining.

## Hudson, Wis., Bridge

Traffic from Hudson, Wis., has had to cross the St. Croix river at Stillwater several miles north in order to reach St. Paul, and for many years the need of a permanent bridge at Hudson has been recognized. The St. Croix river at this point is about ⅜ of a mile wide and the channel, located on the Minnesota side, is narrow and deep. A bluff rises directly from the river. On the Wisconsin side there is shallow water for a distance of 2,000 feet.

Designs were prepared by C. A. P. Turner, of Minneapolis, for a crossing consisting of 2,300 feet of fill on the Wisconsin side and steel construction for the balance, 830 feet long, supported for the most part on reinforced concrete piers.

The center span over the channel has a height of 53 feet above high water.

The reinforced concrete piers are of considerable interest. They consist of columns of the mushroom type and reinforced girders. The columns are 4 and 5 feet high which are in turn supported by piles driven into the bed of the river. Most of the concrete construction was done in winter working thru the ice.

The bridge was built by the Central States Bridge Co., of Indianapolis, for the St. Croix Bridge Co., a private corporation with whom the City of Hudson shared the expense.

## Tarred Concrete in Portland, Me.

*By Edwin D. Lynch, Asst. Engr. Dept. Public Works.*

The first section of state highway in Portland, Me., was built of penetration macadam in 1908. Following that were two sections of bituminous concrete (hand-mixed macadam) and two sections of tarred concrete. It was found that the bituminous forms of construction were not economical; almost constant maintenance being necessary during the summer season. In 1911 a section of tarred concrete was laid and while not entirely satisfactory, was so much more so than the bituminous work that the same kind of pavement was laid on the fifth section of state highway in 1912.

This section lies on Washington avenue, between Gould and Galvin streets. The roadway is occupied by a double track in the center, leaving a paved section on each side that varies from 9 to 15 feet in width, according to location. This section is 3016 feet long and its area 7646 sq. yds.

In connection with the work was laid 826 lin. ft. of 8-in. vitrified pipe underdrain at a cost of 60 cents per ft. Total cost $495.60. The contract price per sq. yd. for concrete surfaced with bitumen and including grading was $1.30. Total cost $10,367.07.

A general description of the work follows:

The street was excavated to a depth of five inches below grade and thoroly compacted with a tandem roller. On the bed thus prepared was laid 5 inches of 1:2½:5 concrete mixed in a Foote 5A mixer. After being mixed, the concrete, which was of a rather thick, creamy consistency, flowed down an iron chute (attached to the mixer) to the bed. In this manner the concrete was placed with practically no separation of its ingredients.

The concrete was then tamped and floated with wooden floats, as shown in the illustrations. By this floating method a general even surface was obtained with the stone as near the surface as is possible to get it. After one day's setting, the concrete was covered with sand, kept wet, and allowed to set for seven days. It was then opened to travel.

After a considerable delay (the contractors' apparatus not having arrived) the concrete was carefully broomed and a bituminous top called Hassamite was applied with a pressure machine. As the bitumen was applied, it was covered with clean, coarse sand and rolled with a tandem roller.

PLACING *concrete on Washington Ave., Portland, Me.*

The bituminous surface, after rolling, averaged ⅜ inch in thickness.

The work was done by the Hassam Paving Co. of Worcester, Mass. The total cost per sq. yd. of completed pavement was $1.36.

The following calculations show the detailed labor costs of mixing in Job "A":—

JOB "A"—3,100 SQ. YDS.

*Base*—5 in., 1:3:5.

Average output—530 sq. yds. Time, 5.7 hrs.

| | *Total.* | *Per Sq. Yd.* |
|---|---|---|
| 9 men on rock at 22½ cents | $11.55 | $0.0218 |
| 3 men on sand at 22½ cents | 3.85 | 0.0073 |
| 1 man at skip at 22½ cents | 1.28 | 0.0024 |
| 1 man wheeling cement at 22½ cents | 1.28 | 0.0024 |
| 1 man leveling concrete at 25 cents | 1.43 | 0.0027 |
| 1 helper leveling concrete at 22½ cents | 1.28 | 0.0024 |
| 1 tamper at 22½ cents | 1.28 | 0.0024 |
| 1 engineer at 25 cents | 1.43 | 0.0027 |

FLOATING *concrete on Washington Ave., Portland, Me.*

| | | |
|---|---|---|
| 1 fireman at 25 cents... | 1.43 | 0.0027 |
| 1 brick operator at 15 cents ..... | 0.86 | 0.0016 |
| 1 water boy at 5 cents.. | 0.28 | 0.0005 |
| 1 sack boy at 5 cents... | 0.28 | 0.0005 |
| 1 foreman at 45 cents.. | 2.57 | 0.0048 |
| Total .....$ | 28.80 | $0.0543 |

*Wearing surface*—1½ in., 1:1:1.

Average output, 530 sq. yds. Time, 2.8 hrs.

| | | |
|---|---|---|
| 4 men on granite chips at 22½ cents.....$ | 2.52 | $0.0048 |
| 4 men on sand at 22½ cents ..... | 2.52 | 0.0048 |
| 2 men at skip at 22½ cents ..... | 1.26 | 0.0024 |
| 2 men wheeling cement at 22½ cents..... | 1.26 | 0.0024 |
| 2 rough spreaders at 22½ cents ..... | 1.26 | 0.0024 |
| 1 fine spreader at 25 cents (also tamps top) | 0.70 | 0.0013 |
| 1 fireman at 25 cents... | 0.70 | 0.0013 |
| 1 bucket operator at 15 cents ..... | 0.42 | 0.0008 |
| 1 water boy at 5 cents.. | 0.14 | 0.0002 |
| 1 sack boy at 5 cents... | 0.14 | 0.0002 |
| 1 foreman at 45 cents.. | 1.26 | 0.0024 |
| Total .....$ | 12.88 | $0.0245 |

*Finishing* (530 sq. yds.)

| | | |
|---|---|---|
| 1 finisher, 13 hrs., at 25 cents .....$ | 3.25 | $0.0061 |
| 1 helper, 13 hrs., at 22½ cents ..... | 2.93 | 0.0055 |
| Total .....$ | 6.18 | $0.0116 |

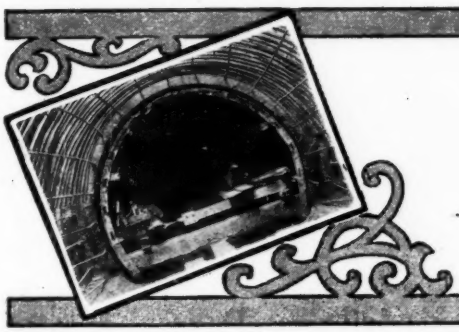
*Form Setter.*

| | | |
|---|---|---|
| 1 man, 10 hrs., at 22½ cents .....$ | 2.25 | $0.0042 |

*Miscellaneous.*

| | | |
|---|---|---|
| 1 man trimming grade, 10 hrs. .....$ | 2.25 | $0.0042 |
| 2 men cleaning up stone and sand, etc., while top is being placed, 4.3 hrs. each ..... | 1.49 | 0.0036 |
| Total .....$ | 4.19 | $0.0079 |

FINISHED *concrete surface on Washington Ave., Portland, Me.*



# CONCRETE

## The McCallie Avenue Viaduct at Chattanooga, Tenn.

The beginning of the end for railroad crossings at grade in Chattanooga, Tenn., was celebrated recently when the new McCallie avenue viaduct was opened for traffic. This is not to say that the McCallie avenue viaduct is the first in Chattanooga, but it is the largest and best yet erected, and almost simultaneously with its completion the Supreme Court of Tennessee handed down a verdict that he railroads themselves should build viaducts where needed. In the instance of the viaduct just completed the city agreed, in order to hasten the work, to paying $20,000 toward the expense. As a result of the decision referred to it now seems that other badly needed viaducts will be erected reasonably soon. Friendly negotiations have been concluded for a viaduct over the tracks of the same companies affected by the McCallie avenue viaduct, namely, the Cincinnati, New Orleans & Texas Pacific and the Nashville, Chattanooga & St. Louis, at East End avenue, not far from McCallie avenue. The Southern Railway has for years maintained several small viaducts in Chattanooga, two of which within a few years have been rebuilt of reinforced concrete. These, however, are small compared to the one just completed and the other which will be built this year.

A frame and uncovered steel viaduct preceded the new one at McCallie avenue. Fumes from passing engines proved the undoing of this old structure, which also proved entirely inadequate to the demands upon it, there being a double track street car line besides facilities for vehicle traffic and foot passengers. The new structure is thoroly modern. Its cost is roundly $100,000, met by the two railroads with the exception of $20,000 by the city, as explained, which is not affected by the court decision, and some $8,000 by the street railway company.

Work on the McCallie avenue viaduct began April 18 last, when a force commenced razing the old structure. The constructing company, Chickamauga Quarry and Construction Company, began operations a week later, the contract having been let by the railroads after plans and specifications were passed on by their engineers and the city engineer jointly. By December 10 the work was practically completed, including paving of one side of the roadway by the city, and operation of the cars was begun on the permanent tracks to permit completion of a small section of the viaduct at the western extremity and one section of the handrail at the eastern extremity, which were necessarily left to the last because the temporary trestle for cars swung in so close to the lines of the viaduct. No serious delays or accidents were experienced, and it is considered that the contractor made splendid time.

Approximately 10,000 tons of concrete went into the viaduct, which is 735.5 feet long, made up of 21 spans. In width it is 60 feet, divided into roadway 40 feet and sidewalks 10 feet each. This is 12 feet of clear vehicle roadway between the outer car rail and curb on each side. The entire roadway is paved with brick. Ornamental posts, carrying trolley wire and lights, are placed on each side of the structure, being fastened in openings provided in the extended ends of spans. These posts are of the standard type used by railway companies. Each is made up of three sections, one 7 inches in diameter, another 6 inches and the third 5 inches. Each post terminates in a spiral, from which is suspended one 108-watt Mazda lamp. As there are fourteen of these posts, seven on each side, it can be easily appreciated that the structure at night is brilliantly lighted. This same style of light, it might be said parenthetically, was recently substituted for the old type arcs on the bridge across the Tennessee river, and the result was amazing as well as exceedingly pleasing to the public. The viaduct posts were furnished to the railway company by the National Tube Company of Pittsburgh.

The viaduct is all flat span work. The working force averaged 80 men and the pay-roll was about $1,000 a week. The contracting firm is the first in this section to use chutes for depositing concrete in place, and this method explains the quick time in which the viaduct was completed with a comparatively small force. The pilasters and hand rails were set in place. Two towers, made by the Insley Manufacturing Company, Indianapolis, were used in depositing concrete for the main work, one being placed on either side of the tracks. Material for the pilasters and hand rail was mixed and placed by hand.

Steel in the beams is two inches off the bottom, this being a slight variation from usual practice so as to render most remote the wearing away of concrete to such an extent that smoke fumes could get at the steel and disintegrate it. In the floor slabs the steel is 1½ inches off bottom. The 500 tons of twisted steel used for reinforcement, varying from ¼ inch to 1½ inches, was furnished by the Corrugated Bar Company, Buffalo, N. Y.

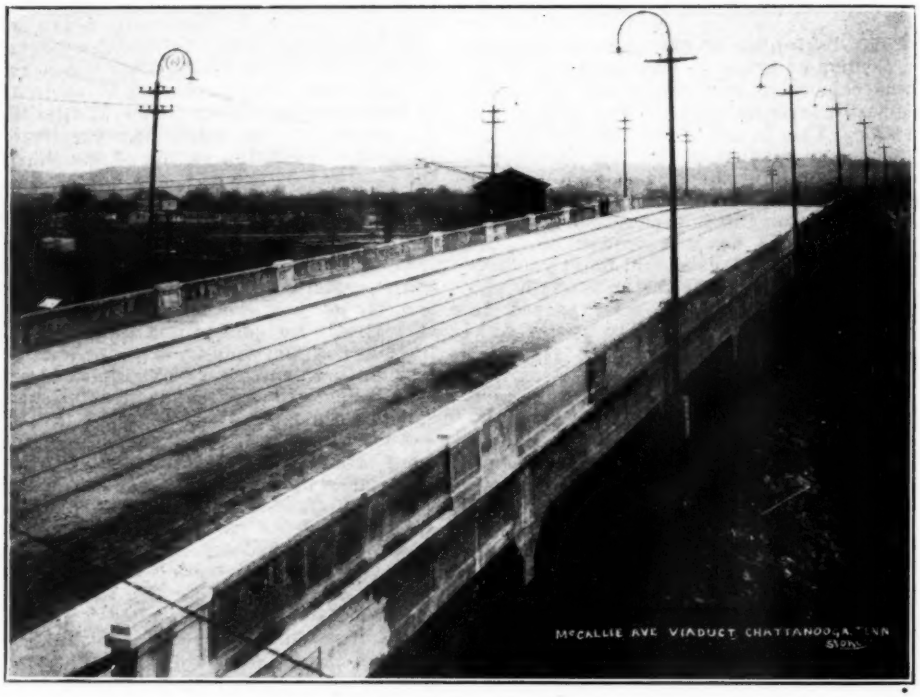
The longest span in the viaduct is 30 feet, and the piers are from 12 to 30 feet high, including footings. The standard factor of safety, four, was used in determining dimensions. The piers are set about six feet below the top of natural earth, the footings spread out to 10 by 8 feet, as there is no rock within reasonable reach in the formation of the vicinity. The piers themselves are 5 by 18 feet. In the footings railroad iron laid in courses was introduced.

Ten thousand barrels of Royal Portland cement, made by the Dixie Portland Cement Company, went into the viaduct. The contracting company makes a specialty of crushed stone and furnished this material for the viaduct.

The grade of the viaduct is 5.3 per cent. on the eastern approach and 5.5 per cent. on the western approach.

As twelve railroad tracks pass under the viaduct at an angle of about 70 degrees to the line of the street, it was necessary to set eight piers askew in order to overcome the difference without too greatly disturbing the tracks or killing too much room that might be used in future for more tracks.

Maximum distance of the structure above ground is about 26 feet, this being over the tracks themselves, the tracks being on a fill. The viaduct is about 18 feet above natural level of the ground at either end.




THE McCALLIE AVENUE VIADUCT *at Chattanooga, Tenn., is a handsome reinforced concrete structure abolishing a dangerous grade crossing.*

On account of the street car service entering into the problem ten longitudinal beams were provided, whereas without the car traffic probably six would have sufficed.

The construction company used in form work some 150,000 feet of small lumber, besides 66 steel I-beams, 12 inches by 26 feet, and 200 8-inch poles for posts.

On the north side of the viaduct, about midway, the operating department of the C., N. O. & T. P. had the contractor build a stairway leading to the railroad yards below for benefit of the yard force. This was handled as an expense aside from the general contract, as it affected only the railroad named.

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## Specifications for Concrete Curb and Gutter of the American Concrete Institute

CURB AND GUTTER.

*Materials.*

1. Cement—The cement shall meet the requirements of the standard specifications for Portland cement of the American Society for Testing Materials and adopted by this association. (Standard No. 1.)

2. Fine Aggregate—Fine aggregate shall consist of sand, crushed stone or gravel screenings, graded from fine to coarse and passing, when dry, a screen having ¼-inch diameter holes; shall be preferably of silicious material, clean, coarse, free from dust, soft particles, loam, vegetable or other deleterious matter, and not more than 3 per cent. shall pass a sieve having 100 meshes per linear inch. Fine aggregate shall be of such quality that mortar composed of 1 part Portland cement and 3 parts fine aggregate by weight when made into briquettes will show a tensile strength at least equal to the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand. In no case shall fine aggregate containing frost or lumps of frozen material be used.

3. Coarse Aggregate—Coarse aggregate shall consist of inert materials such as crushed stone or gravel graded in size, retained on a screen having ¾-inch diameter holes; shall be clean, hard and durable, free from dust, vegetable or other deleterious matter, and shall contain no soft, flat or elongated particles. In no case shall coarse aggregate containing frost or lumps of frozen material be used. The maximum size of coarse aggregate shall be such as to pass a 1¼-inch ring.

4. Natural Mixed Aggregates—Natural mixed aggregates shall not be used as they come from the deposit, but shall be screened and remixed to agree with the proportions specified.

5. Sub-Base—Only clean, hard, suitable materials, not exceeding 4 inches in the largest dimension, shall be used.

6. Water—Water shall be clean, free from oil, acid, alkali or vegetable matter.

7. Coloring—If artificial coloring material is required, only mineral colors shall be used.

*Sub-Grade.*

8. Depth Below Grade. (a) Concrete Curb—When a sub-base is required, the sub-grade shall not be less than 30 inches below the established grade of the curb.

(b) Concrete Curb and Gutter—When a sub-base is required, the sub-grade shall not be less than 11 inches below the established grade of the gutter.

9. Preparation—All soft and spongy places shall be removed and all depressions filled with suitable material, which shall be thoroly compacted in layers not exceeding 6 inches in thickness.

10. Deep Fills—When a fill exceeding 1 foot in thickness is required to bring the work to grade, it shall be made in a manner satisfactory to the engineer.

11. Drainage—When required, a suitable drainage system shall be installed and connected with sewers or other drains indicated by the engineer.

*Sub-Base.*

12. Thickness. (a) Concrete Curb—On the sub-grade shall be spread a material as hereinbefore specified, which shall be thoroly rolled or tamped to a surface at least 24 inches below the established grade of the curb.

(b) Concrete Curb and Gutter—On the sub-grade shall be spread a material as hereinbefore specified, which shall be thoroly rolled or tamped to a surface at least 6 inches below the established grade of the gutter.

13. Wetting—While compacting the sub-base, the material shall be kept thoroly wet and shall be in that condition when the concrete is deposited.

*Forms.*

14. Materials—Forms shall be free from warp and of sufficient strength to resist springing out of shape.

15. Setting—The forms shall be well staked or otherwise held to the established lines and grades, and their upper edges shall conform to the established grade of the curb or curb and gutter.

16. Treatment—All wood forms shall be thoroly wetted and metal forms oiled before depositing any material against them. All mortar and dirt shall be removed from forms that have been previously used.

*Construction.*

17. Dimension of Curb—The section of the curb shall conform with that shown in plans. The thickness at the base shall not be less than 12 inches, and at the top not more than 6 inches, with a batter on the street side of 1 to 4.

18. Dimensions of Curb and Gutter—The sections of the combination curb and gutter shall conform with that shown in plans. The depth of the back of the curb shall not be less than 6 inches. The breadth of the gutter shall not be less than 16 inches nor more than 24 inches.

19. Size of Sections—The curb and gutter shall be divided into sections not less than 5 nor more than 8 feet long by some method which will insure the complete separation of the sections.

20. Section at Street Corners—The construction of the combination curb and gutter at street corners shall conform with that shown in plans. The radius of the curb shall not be less than 6 feet.

21. Width and Location of Joints—A ½-inch expansion joint shall be provided at least once in every 150 feet.

22. Joint Filler—The expansion joint filler shall be a suitable, elastic, waterproof compound that will not become soft and run out in hot weather, nor hard and brittle and chip out in cold weather.

23. Protection of Edges—Unless protected by metal, the upper edges of the concrete shall be rounded to a radius of ½-inch.

*Measuring and Mixing.*

24. Measuring—The method of measuring the materials for the concrete, including water, shall be one which will insure separate uniform proportions at all times. A sack of Portland cement (94 pounds net) shall be considered 1 cubic foot.

25. Machine Mixing—When the conditions will permit, a machine mixer of a type which insures the uniform proportioning of the materials thruout the mass shall be used. The ingredients of the concrete or mortar shall be mixed to the desired consistency and the mixing shall continue until the cement is uniformly distributed and the mass is uniform in color and homogeneous.

26. Hand Mixing—When it is necessary to mix by hand, the materials shall be mixed dry on a water-tight platform until the mixture is of uniform color and the required amount of water added, and the mixing continued until the mass is uniform in color and homogeneous.

27. Retempering, that is, remixing mortar or concrete that has partially hardened, with additional water, will not be permitted.

TWO-COURSE CURB AND GUTTER.

*Base.*

28. Proportions—The concrete shall be mixed in the proportion of 1 sack Portland cement, 2½ cubic feet fine aggregate and 5 cubic feet coarse aggregate.

29. Consistency—The materials shall be mixed wet enough to produce a concrete of a consistency that will flush readily under slight tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar.

30. Placing—After mixing the concrete shall be handled rapidly and the successive batches deposited in continuous operation completing individual sections. Under no circumstances shall concrete be used that has partially hardened. The gutter forms shall be filled and the concrete struck off and tamped to a surface the thickness of the wearing course below the established grade of the gutter. The concrete for the curb shall be placed and tamped so as to permit of the application of the required wearing course to the face and top so as to bring the work to the established line and grade of the curb. The work shall be executed in a manner which will insure perfect joints between abutting sections. Workmen shall not be permitted to walk on freshly laid concrete, and if sand or dust collects on the base, it shall be carefully removed before the wearing course is applied.

*Wearing Course.*

31. Proportions—The mortar shall be mixed in the manner hereinbefore specified in the proportion of 1 sack Portland cement and not more than 2 cubic feet of fine aggregate.

32. Consistency—The mortar shall be of a consistency that will not require tamping, but which can be easily spread into position.

33. Thickness—The wearing course of the gutter and top and face of the curb shall have a minimum thickness of ¾ of an inch.

34. Placing—The wearing course shall be placed immediately after mixing, and in no case shall more than 50 minutes elapse between the time the concrete for the base is mixed and the time the wearing course is placed.

35. Finishing—After the wearing course has been brought to the established line and grade it shall be worked with a wood float in a manner which will thoroly compact it. When required, the surface shall be troweled smooth, but excessive working with a steel trowel shall be avoided. The section markings shall be made in the wearing courses directly over the joints in the base with a tool which will completely separate the wear-

ing courses of adjacent sections. If excessive moisture occurs on the surface, it must be taken up with a rag or mop, and in no case shall dry cement or a mixture of dry cement and sand be used to absorb this moisture or to hasten the hardening. The edge of the curb on the street side and the intersection of the curb and gutter shall be rounded to a radius of about 1½ inches. All other edges shall be rounded to a radius of ⅜-inch unless protected by metal.

36. Coloring—If artificial coloring is used, it must be incorporated with the entire wearing course and shall be mixed dry with the cement and aggregate until the mixture is of uniform color. In no case shall the amount of coloring used exceed 5 per cent. of the weight of the cement.

*One-Course Curb and One-Course Curb and Gutter.*

The general requirements of the specifications covering two-course work will apply to one-course work, with the following exceptions:

37. Proportions—The concrete shall be mixed in the proportion of 1 sack Portland cement and not more than 2 cubic feet of fine aggregate and 3 cubic feet of coarse aggregate passing a one-inch ring.

38. Placing and Finishing—The forms shall be filled, the concrete struck off and the coarse particles forced back from the surface, and the work finished in usual way.

*Protection.*

39. Treatment—As soon as the concrete has hardened sufficiently to prevent being pitted, it shall be sprinkled with clean water and kept wet for at least 4 days. The work shall not be opened to traffic until the engineer so directs.

40. Temperature Below 35 Degrees F. —If at any time during the progress of the work the temperature is, or in the opinion of the engineer will within 24 hours drop to 35 degrees Fahrenheit, the water and aggregates shall be heated and precautions taken to protect the work from freezing for at least 5 days. In no case shall concrete be deposited upon a frozen sub-grade or sub-base.

## An Advertising Sidewalk

*By James W. Beebe.*

About three years ago some of the more enterprising citizens of Hope, Ark., extended a concrete walk about one-half mile to a new park that had recently been acquired by the city. As the city had no funds to pay for this improvement the work was paid for by selling advertising space on the walk.

Under the original plan the width was to have been 6 feet. This was later changed to 5½ in order to save cost.

The estimated cost was determined and from this the cost per square. About 10 per cent. was added to cover the cost of constructing squares that might not be sold. Using this price as a basis, about $5.00 per square, advertisements were solicited from all leading manufacturers selling thru the local merchants.

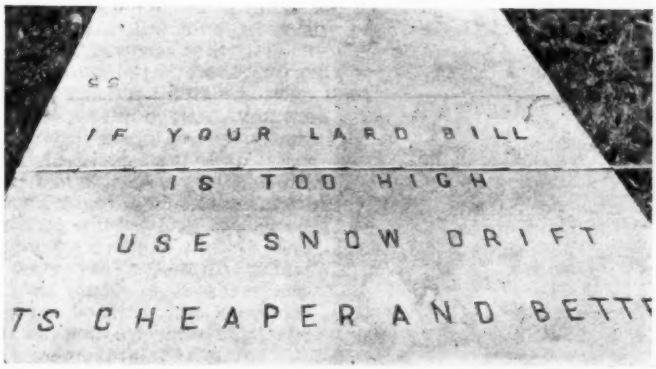
Form letters were used, signed and mailed by the local merchants. Postage and envelopes as well as the letters were furnished by the committee in charge.

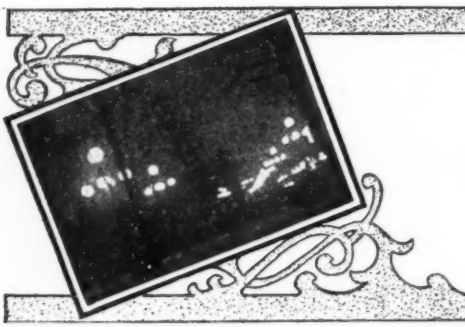
A few manufacturers refused to purchase any space but many took two or more spaces. However, before construction work was started the committee found it necessary to reduce the width from 6 to 5½ feet in order to bring the cost within the fund obtained.

The advertisements are all very plain and readable, excepting a few well known trade marks.

Three or four of the advertisements were made by placing metal letters in the top of the walk, the remainder were made by stamping with bronze letters. These are the more readable. About all of the letters are 3 inches high and of a corresponding width.

Several squares were used to give a short history of the town and county and the names of the committee who originated the plan and carried it to a successful completion.





# Lighting

## Business Block Lighting

"No more dark and dingy principal thorofares in a modern city." This seems to be the key note of the times regarding street illumination. The principle applies not merely to the more effective lighting of streets by the ordinary public lighting systems, of which there are many varieties, but extends beyond this to the use of thousands of tungsten lamps on ornamental standards set at regular intervals along the curb. These are maintained by individuals who arrange thru business men's associations, improvement clubs, and even individually, with the central station company which installs the posts, provides the current, cleans the globes and maintains the lamps in good order for a specified sum per post per month.

A few years ago this scheme was tried out in a small way as a more attractive form of street lighting than the use of high candlepower arc lamps, and was found to be an immediate and tremendous success as a business stimulator and booster in any neighborhood to which it was applied. Since then the idea has grown to tremendous proportions in cities like Chicago, where many miles of business streets are thus illuminated.

As might be expected, the smaller towns all over the country have developed the idea even more rapidly than the big cities, probably because local associations are closer and the arrangements are more easily consummated among local business men, all of whom are more familiar with each other than those who are further apart in the big cities. If you go to any live town you will find some special forms of street illumination on perhaps two or three thorofares among which the ornamental street lamp post is sure to be conspicuous. Festoon lighting does not give the same air of permanence to the enlivened aspect of the street as lamp posts set at regular intervals along the curb. It smacks more of the fleeting brilliance of a carnival occasion of some sort; also, it fails to benefit store windows or light the sidewalk to the same degree. As a matter of fact, it is these latter which require the illumination and not the narrow strip between the car tracks.

Our illustration will give some idea of some recent installations in Chicago. In one section, on the northwest side, reached by evcellent transportation both on the surface cars and the Northwestern elevated, the Ravenswood branch of which is here extended on the surface, there is a large tract of desirable property which is being sold to people who are erecting homes thereon. At both sides of every street entrance to this tract will be found ornamental, substantial looking, brick columns, each surmounted by a large globe containing a powerful tungsten lamp. For half a mile on Western avenue, in the center of the tract, tungsten street lighting posts are installed along the curb on both sides of the road, and passengers riding out there cannot fail to realize as soon as they come within that bright zone that they are in a section which is distinguished from its surroundings, a section where enterprise and energy and the spirit of improvement are manifesting themselves. The lighting continues along Lawrence avenue and along other arteries of transportation. There is no doubt that the promoters of this tract have chosen a very wise and effective method of hastening its improvement.

## High Efficiency Incandescent Lamps

*This extract from a paper by S. E. Doane, chief engineer of the National Lamp Works of the National Electric Company, gave an explanation to the Wisconsin Electrical Association at its January convention of the principles upon which the efficiency of the modern gas pressure incandescent lamps depends, as compared with the vacuum lamps of the past.*

The incandescent electric lamp gives light because the filament is hot. Anything which tends to cool the filament requires more energy to maintain the requisite temperature. Lamps burn out for two essential reasons in general: First. The filament becomes attenuated by evaporation. Second. The metal of the filament is attacked chemically. The economics of the incandescent lamp and its application to the industry all have to do with the cost of the lamp and its life. The life of the lamp is regulated, speaking generally, by the filament diameter. Two perfectly obvious laws apply, as one would expect. The thicker the filament the slower it is to evaporate to the time when it becomes too weak to maintain its structure. The thicker the filament the less quickly it is destroyed chemically. The cost of the lamp is not in the ratio of its wattage or candle power or any other size determinant, consequently there must exist between small lamps and large lamps that same relation which we find in anything else, from central stations to agriculture.

Incandescent lamp design must at all times maintain a nice balance between various factors. The incandescent lamp could not exist without this nice balance, and the industry exists but haltingly unless this balance is maintained. We must forever abandon the idea that anyone can run a pair of wires and stick a lamp at one end and a dynamo at the other and furnish lighting service. The early lighting service was almost as crude, and the principal progress we have made between the early days and the present is progress in the adjustment of this balance, both on the part of the lamp manufacturers and the central station industry. We have not as yet fully assimilated this idea.

The efficiency of the incandescent lamp in its most modern, its latest, its most extreme development, is only about 12 per cent. on basis of black body maximum, so that while we are pleased to talk about the high efficiency lamp, the term is a misnomer. It is a most inefficient piece of electrical apparatus. This latest development is tungsten wire coiled into a small area to reduce convection loss when operated under gas pressure to reduce evaporation. Commercially it will, of course, modify your practice to some extent. Unless the arc lamp people get out something new the end of the arc lamp is indicated as clearly as is that of all of the other older types of electrical illuminants. Absolutely every type of electric lamp of every size from the battery lamp to the arc size is being replaced by the tungsten filament lamp. Special applications in which the other illuminants for one reason or another are useful may endure for some time, but as a general business proposition there is nothing left which can compete with the tungsten filament lamp. Any real competitor to the new lamp must come from new development; whether it will be arc or something else, no one can foresee.

I anticipate that there will be much inquiry relative to these lamps. It is needless to say that they are of so recent birth that we do not know enough about them, but it would seem as if at the highest amperage (perhaps 20) we might reach as low as ½-watt per candle at present. As we progress downward toward the lower amperages there comes a place where the vacuum lamp is more efficient, the reason being, of course, that the less mass of wire allows a greater percentage of loss due to heat convection and conduction.

The same old differentiation holds that low voltage lamps of a given wattage will be of a higher efficiency than the high voltage lamps of the same wattage. The bulbs of these lamps get hot. It may be necessary to protect them from the weather. It is an open question in my mind as to whether or not you can afford to use individual compensators at each street series socket to obtain the high efficiency of the 20-ampere lamps. I am inclined to think that the use of high efficiency street service lamps will be made possible thru the use of higher amperage in street series circuits to the limit of good engineering practice. In the substituting for arc lamps it may prove to be feasible to introduce a small compensator in each lamp where a circuit is not to be changed thruout, or can not take a high amperage safely.

The principle underlying this application of gas pressure to the lamp is the same principle by which you can heat water in a steam boiler under pressure to a temperature higher than the temperature at which it boils in the open air. If instead of having pressure on your boiler you have a negative pressure, that is, a vacuum, we know that water boils at a lower temperature than in the open air. Similarly ice in a vacuum may be made to pass into vapor without melting.

So it is that every substance can exist as a solid, liquid or vapor under proper conditions of pressure and temperature.

It is obvious that the incandescent electric lamp has consisted during many years of a conductor heated electrically in a vacuum. The reason for the vacuum is to avoid chemical action and convection losses. The heated conductor evaporates at a lower temperature in the vacuum than it would under pressure.

Another law comes into effect in connection with the operation of these lamps which has been very little considered, and that is that the amount of convection loss from a heated wire is considerably greater if this wire is suspended in an open coil or not carefully concentrated.

It is obvious that we have not had to pay attention to this law with a lamp filament operated in a vacuum, but in these non-vacuum lamps it is necessary to mass the filament. We use a thick filament coiled closely upon itself.

The most wonderful thing about this recent development is the fact that for the first time in the history of the industry incandescent lamps are commercially made without a vacuum. The business effect of this invention is not revolutionary as is the scientific effect of it. The new development will simply extend the commercial fields to which incandescent lamps have been applied in the past.

Without any thought of detracting in any sense from the fullest credit for the scientific value, I wish to speak a word of caution. There are many other achievements which have been made, which will undoubtedly be made and which will be employed, but which will not obtain the publicity of this particular one. I would suggest in referring to lamps of this character in any discussions that the lamps be referred to by their efficiency and size, without regard to the particular construction which makes these efficiencies possible at the sizes given.

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## Elements of Charge for Public Utility Service

*The summary of an address by M. E. Cooley at the annual dinner of the Western Society of Engineers gives in brief space a classification of the sources of expense which must be met by the charges for service by a public utility plant, which is apparently complete, and may be considered by some as leaving the way open for duplicating some of the charges.*

It will be convenient to bring together the several elements which take part in determining a reasonable charge for public utility service. Not all of them take part at the same time necessarily, for some may appear in one case and not in another; or several may be combined in a single item. In a general way, and in a somewhat natural order, they may be summarized as follows:

*First. Capital Investment.*

1. Preliminary costs covering investigations as to feasibility of project.

Note.—Organization, promotion, administration and legal expenses, engineering and superintendence during construction, which are distributed over the whole period of construction, are more conveniently placed later in the schedule.

2. The physical property; the several items making up the whole arranged in order, each affected with its proper allowances to cover contingencies, special engineering, and other costs peculiar to the item; land first, followed by clearing and grubbing, then the various structures and equipment; sub-contractor's profits included with the separate items.

3. General contingencies applicable to the property as a whole as distinguished from special contingencies applicable to particular items.

4. General contractor's profits; or, the profits to an engineering firm building the property on the "cost plus a percentage" plan.

5. General engineering, and superintendence during construction.

6. Insurance and taxes.

7. Organization, administration and legal expenses.

8. Cost of promotion and promoter's profits.

9. Interest during the construction period.

10. Office furniture and fixtures.

11. Stores and supplies.

12. Working capital.

*Second. Operating Expenses.*

13. Operating expenses per se; that is, salaries, wages, fuel and other supplies, repairs and upkeep; all expenditures required in rendering the service of the utility, including insurance and taxes.

14. Interest on the capital investment (the actual cost of the property), i. e., interest on securities which must be paid regularly.

15. Interest on floating debts; this may include the discount on bonds, and the cost of financing, if these have not been incorporated with the capital.

16. Cost of establishing the business; the sums of money required to be borrowed, with interest on the same, to make good the differences between the earnings and expenditures up to the time the earnings become sufficient to meet all expenditures. This may be made a capital charge, or carried as a floating debt to be paid out of future earnings.

*Third. Depreciation Fund.*

17. The regular contribution to the

depreciation fund, out of which the integrity of the property is to be maintained.

*Fourth. Sinking Fund.*

18. The annuity required to retire such portions of the securities as may be necessary at the expiration of the franchise life of the property, in order that the investor may receive back his entire principal when the business is closed out.

It will surprise everyone not familiar with the cost of building public utility plants to learn that the so-called overhead charges are in the aggregate a large percentage of the costs of labor and the material things entering into their construction. An examination of the various percentages, omitting items 1, 4, 8, 15 and 16, will disclose that if the individual contingencies of construction, special engineering charges, and contractor's profits be assumed to be embraced in item 2, the total percentage may vary from 12 to 25 per cent.; and if these inside percentages be added to the outside or general percentages, the total percentage may vary from 30 to 60 per cent.

It is to be regretted that engineers and others who have had experience in building properties, and valuing them afterwards, have not done more towards disseminating knowledge of the actual conditions found in such work. We should then be much further along towards the mutual understanding which must exist before the public service corporation can get together on common ground. But engineers have many times hesitated to use the larger percentages, fearing to be accused of favoring the corporation.

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## Flower Boxes in Chicago

*By L. A. Dumond, Chairman Committee on Downtown Streets, Chicago Association of Commerce.*

The Committee on Downtown streets has been working in conjunction with business men and officials in its campaign to introduce growing plants into the loop district of Chicago. Almost every building in the loop district should bloom with flower boxes.

This plan is in no way experimental. Minneapolis has maintained flower boxes successfully for two years and in that city those who tried the plans are without exception enthusiastic supporters of the idea of bringing nature into the business districts.

Many large business concerns in Chicago are preparing to fit their windows with flower boxes and it is our intention to have a demonstration of flower boxes for trolley poles ready for inspection in a short time.

The use of flower boxes has a favorable effect upon one's trade and one's employes. Progressive manufacturers in Chicago and elsewhere have found that more and better work can be secured from employes when the windows of the working rooms are filled with growing plants.

What is true of the manufacturers is true of all other lines of business. Those who have tried the plan find that they cannot afford to be without the growing plants. Flower boxes exert an influence both from the inside and from the outside. In other cities tenants in offices too high to he seen from the street have maintained flower boxes for the influence they seem to have upon their employes and their clients. In a mechanical age, when surrounded on every side by things artificial, the use of growing plants is the one touch of nature that brings us back to real things.

Experience with flower boxes in Chicago and elsewhere has proven that growing plants can be maintained for months with a little regular attention, that the flower boxes do not fall down on pople's heads, and that they do not leak and stain the building. The best results seem to have been obtained by the use of a sub-irrigated flower box. Wherever flower boxes are cared for by the tenants, this box is preferable.

There is no hard and fast price per lineal foot. Much will depend upon the kind of plants selected and upon whether the boxes are cared for by the tenant or by the florist. Ordinary wooden and galvanized iron boxes cost about 50 cents per lineal foot. The sub-irrigated flower box about 88 cents per lineal foot. The cost of summer plants will vary from $1.00 to $1.50 per lineal foot. Winter plants will cost about 60 cents per lineal foot.

The plants may be cared for by the tenants or by the florist. If cared for by the tenants regularity in watering is essential to success. Growing plants may be rented from the florists for the summer season, in which case the work of maintenance is done by the florist.

# MISCELLANEOUS

## Iron and Steel Processes and Their Relation to Corrosion

*By J. T. Hay, Chief Metallurgist and Chemist of Steel Rolling Mill Co., at College of Applied Science of Syracuse University, New York.*

The progress in the art of manufacturing iron and steel has been most remarkable in the last few years and of all the factors which have contributed towards it none has been more influential than the destructive forces of corrosion, which have challenged the best efforts of man to produce a permanent iron or steel product, and it is a well-established fact that the processes of manufacture have much more to do with the final lasting quality of the material than was formerly supposed.

It is a recognized fact that the open-hearth furnace alone is suitable for the production of high-grade metal in large quantities. The electric furnaces are rapidly forging their way to the front, but they have not been long enough in the field for us to accurately determine their position. Therefore, we will deal with the open-hearth furnace and its production, and try to show some of the many factors in the process of manufacturing which have an influence on the corrosion of the finished products. To begin with, it is necessary that we have raw materials of good quality, pig iron, scrap and fluxes; the standard specifications of basic pig are suited for our requirements. Great care must be taken in the purchasing of scrap, as it requires but a small amount of impurities in the scrap to cause unlimited trouble in the finished product. Cast iron scrap of all kinds is to be avoided. Furnace operations are the next factor to be considered. The education of the men operating the open hearth furnaces is of the utmost importance, and too many manufacturers are prone to allow men of inferior education to carry on this work, and, as a result thereof, inferior products are made.

The proper regulation of the temperature of the furnace is a most important factor, influencing the quality of the product, and the ascertaining of the temperature with the eye, as it is customarily done, is an uncertain proposition at the best. It takes a melter of long experience to determine accurately the temperature by those means, and material which is needlessly overheated in open-hearth furnaces is injured beyond repair, unless it is melted again with new fluxes and pig iron. After the metal has become thoroly molten and the temperature has been carefully watched, a sample is then taken from the bath and carefully analyzed before the material is removed from the furnace. The old method of determining the amount of phosphorus and carbon in the metal by the visual appearance of a fractured test piece is being rapidly superseded by making preliminary chemical analyses before the material is tapped. Too much stress can not be laid upon this point, if quality in the material is aimed at. But even when these precautions are taken, many a heat is ruined by carelessness in tapping and handling the metal when in the ladle. The melter must have before him the conditions to which the metal was subjected during the three or four hours previous to the tapping, together with the preliminary analyses, to determine the necessary treatment in the ladle, as this is his last chance to add to or detract from the quality of the metal.

Many defects in steel can be traced to dirty molds or lack of care in pouring the molten metal therein.

When the ingot has been removed from the mold it is usually placed in a reheating furnace or soaking pit before the ingot is cold. The heat of these pits should always be controlled by a pyrometer, because the temperature must be regulated according to the chemical analysis of the metal. Much good material is ruined at this point for lack of knowledge as to its proper heat treatment. But at large plants chemists are working out these details and thus improving the quality and increasing the quantity.

We have now reached the stage of changing from a chemical to the physical treatment of the metal. The man in charge of the rolling operations must keep down the speed liimt, and this is true even for the rolling of sheets. After the sheets have been rolled, careful an-

nealing at accurately determined temperatures is absolutely essential.

Let us outline now, but briefly, the theory and effects of corrosion. Corrosion, or the rapid rusting of iron and steel, may be considered as an effect of the combined action of water and oxygen, or, in a broad sense, of moisture and air. The most widely accepted theory of the cause of this rapid rusting or corrosion, called the electrolytic, is based on the fact that when two substances, having different electrical potentials, are immersed in a suitable electrolyte, an electric current is set up and corrosion begins at once. In iron or steel the various impurities differ from the element iron in their electrical potentiality, and the moisture in the air contributes the electrolyte. It is also true that this action is of a chemical nature and that because of the very close connection between electrical and chemical action we are able to control this chemical action by stopping or accelerating the electrical action. The purity of iron has a marked influence on the rapidity of corrosion. The quantity of the impurities must not only be very minute, but those few elements which it is impossible to remove entirely must be absolutely homogeneously distributed. Because of the extreme sensitivity of iron, great care must be used at its physical treatment, or the work of having eliminated the impurities will be labor lost. The strains produced by excessive speed in rolling, unless removed by careful annealing, will generate active corrosion.

Some manufacturers have tried to offset their neglect to remove the objectionable impurities and their lack of careful physical treatment by the addition of copper. This doped steel, instead of being benefited thereby, has to undergo an increase of the total of its impurities, and thus the segregation of the latter is rendered easier, which two factors accelerate corrosion rather than retard it.

## Technical Associations

The February 27 meeting of the New York Electrical Society was held at the new Two Hundred and First street generating station of the United Electric Light and Power Company, and included a history of the company and the development of alternating current supply in the city, an illustrated description of the station and an inspection of the station under special guides.

The second annual meeting of the Chamber of Commerce of the United States in Washington, February 11 to 13, was largely devoted to a discussion of anti-trust legislation and provided for careful committee consideration of all such proposed legislation and referendum of the same to the commercial organizations of the United States.

The American Institute of Quantity Surveyors, San Francisco, Cal., publishes a monthly bulletin of about four pages devoted to the promotion of better methods of estimating and dealing with bids.

The Indiana Sanitary and Water Supply Association held a successful meeting in Indianapolis, February 26 and 27. Water works management, water waste, floods, polluted water and its consequences, water purification and natural conditions, public utility commissions and regulation, machinery, hydraulics, sewage, fire losses, conservation of water, power, health, are some of the subjects considered, most of them by experts.

The American Concrete Institute held its convention with the Chicago Cement Show the third week in February and was attended by about 200 members and visitors. The papers presented were mainly of high grade, but were too numerous to permit much discussion.

The Conference on Concrete Road Building held in connection with the Chicago Cement Show, on February 12 to 14, was organized and the material was presented by committees appointed in advance from the field of experts on the subject. Two of these reports are given elsewhere in this number of MUNICIPAL ENGINEERING, and others will follow later. The attendance was very satisfactory, and the discussions, partly provided for beforehand, were intelligent and to the point. President Goss proved himself an ideal presiding officer and the cause of concrete roads was advanced by showing both the successes and the sources of failures.

The convention of the National Brick Manufacturers' Association opens at New Orleans, March 4. On the program is a paper by W. T. Blackburn, Paris, Ill., on "Brick Paved Highways as an Investment."

The Eastern Paving Brick Manufacturers' Association at its Bradford, Pa., meeting, February 5-7, elected C. E. Foster, Bradford, Pa., president; G. W. Lenkerd, Indiana, Pa., secretary, and C. P. Mayer, Bridgeville, Pa., treasurer.

## Technical Schools

Howard E. Phelps, city engineer of Boulder, Colo., has been appointed assistant professor of civil engineering at the University of Colorado, taking the place of Professor C. C. Williams, who resigned to take the position of professor of railway engineering at the University of Kansas, Lawrence, Kan.

The short course in highway engineering at the University of Illinois was at-

tended by about 200, including 63 of the 66 county superintendents provided for in the new Illinois highway law.

Lectures on highway engineering will be delivered at Columbia University, New York, in March, as follows: On the principles of efficiency engineering applied to highway engineering, by Frank B. Gilbreth, consulting engineer, New York, on the 2d; on the administration of municipal public works, by Nelson P. Lewis, chief engineer, board of estimate and apportionment, New York City, on the 9th; on the essential physical and chemical properties of creosoting oils for wood blocks, by C. N. Forrest, New York Testing Laboratory, Maurer, N. J., on the 16th; and on the relative cost of transportation by waterways railways and highways, by John A. Bensel, state engineer, Albany, N. Y., on the 19th.

## Personal Notes

Benton R. Anderson has been appointed city engineer at Carroll, Iowa.

James E. Sutton is city engineer of Alameda, Cal.

A. S. Zinn, recently resident engineer in charge of the fourth division of the chief engineers' office, Isthmian Canal Commission, has been appointed consulting engineer with the department of public works of the Republic of Panama.

D. W. Johnson becomes city engineer of South Saanish, B. C.

Prof. A. H. Blanchard of the Columbia University graduate course in highway engineering, has recently delivered courses of lectures at the Ohio short course in highway engineering and at the University of West Virginia.

H. E. Brauer is the new city engineer of Shreveport, La.

J. J. Smith, the newly appointed city engineer of East Grand Forks, Minn., will immediately prepare plans for 3,800 square yards of pavement.

D. F. Austin, for many years city engineer of Auburn, N. Y., died recently, aged 83 years.

Hugh L. Cooper, having completed the water power development of the Mississippi River Power Company at Keokuk, Iowa, has opened offices at 101 Park avenue, New York City, for the practice of general hydraulic engineering, including design, construction and management of hydro-electric power plants.

H. F. J. Porter, M. E., and A. L. A. Himmelwright, C. E., have opened offices in Masonic Hall, Twenty-third street and Sixth avenue, New York City, for the purpose of advising architects, owners, public officials, commissions and others on safety to life in buildings, especially with reference to the new factory laws in New York.

## New Publications

The Scientific American Reference Book for 1914 has been thoroly revised and brought up-to-date, which has necessitated the correction of more than half of the pages, in many cases new pages having been substituted.

It is a handy, compact, reliable and up-to-date compendium for everyday reference, containing a remarkable aggregation of facts, statistics and readable information along industrial, commercial, scientific and mechanical lines of interest to every one. It contains over 75,000 facts and is illustrated by about 1,000 engravings, many of them being diagrammatic comparisons. A great deal of the information can not be found elsewhere without considerable trouble and inconvenience.

In the preparation of this volume immense masses of government material have been digested with painstaking care and with the collaboration of government officials. The assistance of competent professors of world-wide reputation has also been secured. No expense and effort have been spared to make the volume interesting as well as authoritative.

The scope of the book is so broad and the information so varied that it is impossible to give in a table of contents an adequate idea of the vast amount of information that it contains or the range of the subjects treated. It is complete and comprehensive—a revelation of facts and figures. If information regarding anything of present-day interest is wanted, it is almost certain to be found in this volume. It will prove invaluable on the desk of the business man, as well as the library of the home.

Chapter headings cover population and social statistics, farms, foods and forests, mines and quarries, manufactures, commerce, merchant marine, railroads, the Panama canal, telegraphs and cables, wireless telegraphy, telephone statistics of the world, postoffice affairs, patents, trade marks and copyrights, armies of the world, navies of the world, aviation, chemistry, astronomy and time, meteorology, machine elements and mechanical movements, geometrical constructions, weights and measures. It has nearly 600 pages and costs $1.50 net.

## Publications Received

The Determination of Internal Temperature Range in Concrete Arch Bridges. By C. S. Nichols and C. B. McCullough. Paper, 101 pp. Bulletin No. 30 of Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

Flood Control of the Mississippi

River; an address by Col. C. McD. Townsend, U. S. A., president of the Mississippi River Commission, before the National Drainage Congress. Paper, 16 pp. Published by the Mississippi River Levee Association, Scimitar Bldg., Memphis, Tenn.

Municipal Handbook of Dallas, Tex., 1913. Leather, 106 pp. S. J. Hay, mayor.

Yearbook of Burlington, N. J. Paper, 105 pp. E. Ellsworth Mount, mayor.

Organization and Administration of the Department of Health of Dayton, O. A report based on an investigation by Carl E. McCombs and prepared for the Department of Health by the Dayton Bureau of Municipal Research and issued by the Board of Health to show its needs. L. D. Upson, director of bureau.

The Prevention of Waste of Oil and Gas from Flowing Wells in California, with a discussion of special methods used by J. A. Pollard. By Ralph Arnold and V. R. Garfias. Paper, 15 pp. Bureau of Mines, U. S. Department of the Interior.

Modern Cities: Progress of the Awakening for Their Betterment Here and in Europe. By Horatio M. Pollock, Ph. D., (Leipzig) and William S. Morgan, Ph. D. (Yale). Cloth, 418 pp. $1.50 net., by mail $1.63.

Business Methods in Municipal Works: An informal record of the operations of the Department of Public Works of the city of Philadelphia, under the administration of Mayor Blankenburg. By Morris Llewellyn Cooke, director of Department of Public Works. Paper, 64 pp. Published at private expense. Copies can be obtained at Room 216, City Hall, Philadelphia, Pa.

Proceedings of Thirty-Third Convention of Indiana Engineering Society for 1913. Paper, 301 pp., 50 cents. Charles Brossmann, secretary, Merchants' Bank building, Indianapolis, Ind.

An Irish Channel Railway. By Henry Grattan Tyrrell, consulting engineer, Chicago, Ill. Paper, 5 pp.

History of Bridge Engineering. By Henry Grattan Tyrrell, C. E. (Toronto), bridge and structural engineer, Evanston, Ill. Cloth, 480 pp., $4. Published by the author.

The Wisconsin State Aid Highway Law. Bulletin No. 3 of Wisconsin Highway Commission. Paper, 54 pp. Madison, Wis.

Seventh and Eighth Annual Reports of the State Highway Department of Ohio, years ending November 15, 1911 and 1912. Paper, 112 and 276 pp. James R. Marker, state highway commissioner, Columbus, Ohio.

Municipal Year Book of the City of New York for 1913. Paper, 190 pp. Robert Adamson, secretary to the mayor.

Work Done for the Prevention of Water Waste in the City of New York and Results Accomplished Thereby. By I. M. DeVarona, Brooklyn, N. Y. Paper, 33 pp.

Text-Book on Highway Engineering. By Arthur H. Blanchard, C. E., A. M., professor of highway engineering in Columbia University, and Henry B. Drowne, C. E., instructor. Cloth, 774 pp. $4.50 net. John Wiley & Sons, New York City.

Proceedings of Brooklyn Engineers' Club for 1912. Paper, 256 pp., $2. Joseph Strachan, secretary, 117 Remsen street, Brooklyn, N. Y.

The Art of Roadmaking: Treating of the various problems and operations in the construction and maintenance of roads, streets and pavements. Written in non-technical language, suitable for the general reader; with an extensive bibliography and a descriptive list of reliable current books and pamphlets on these subjects. By Harwood Frost, B. A. Sc. Cloth, 544 pp., $3 net. Engineering News, New York.

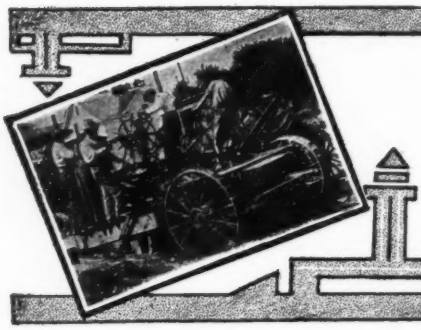
Highway Construction: A practical guide to modern methods of road building and the development of better ways of communication. By Austin T. Byrne, C. E., and Alfred E. Phillips, C. E., Ph. D., professor of civil engineering, Armour Institute of Technology. Cloth, 136 pp., $1 net. American School of Correspondence, Chicago, Ill.

Twenty-Eighth Annual Report of the Board of Gas and Electric Light Commissioners of Massachusetts for 1912. Paper, 717 pp. Forrest E. Barker, Morris Schaff, Alonzo R. Weed, commissioners, Boston, Mass.

Elements of Water Bacteriology: With special reference to sanitary water analysis. Third edition. By Samuel Cate Prescott, associate professor of industrial microbiology in the Massachusetts Institute of Technology, and Charles-Edward Amory Wilson, associate professor of biology, College of the City of New York, and curator of public health, American Museum of Natural History. Cloth, 330 pp., $1.75 net. John Wiley & Sons, New York City.

Vitrified Brick as a Paving Material for Country Roads. By Vernon M. Pierce, chief engineer, and Charles H. Moorefield, senior highway engineer, Office of Public Roads. Paper, 33 pp. Bulletin No. 23 of the U. S. Department of Agriculture, Washington, D. C.

Water Purification and Sewage Disposal. By Dr. J. Tillmans, director of the chemical department of the Municipal Institute of Hygiene, Frankfort-on-Maine. Translated by Hugh S. Taylor, M. Sc., Univ. of Liverpool. With 21 illustrations in the text. Cloth, 143 pp., $2 net. D. Van Nostrand Co., 25 Park Place, New York City.



# MACHINERY AND SUPPLIES

## Aztec Asphalt in Baltimore Pavements

The, asphalt pavements of Baltimore Md., are laid under the standard specifications of the American Society of Municipal Improvements, which are open enough to permit the use of all asphalts suitable for asphalt pavements in cities, at the same time that they are strict enough to exclude asphalts which will not produce good pavements.

The work of the new paving commission of Baltimore was described in part in MUNICIPAL ENGINEERING, January number. Under that body Baltimore is passing rapidly from under its old reputation as a cobble town and now has many miles of pavements which are equal to the best anywhere. Progress would be still more rapid were it not necessary to wait for the construction of sewer lines in the system of sewers and drains which is under construction.

During the past two years a number of streets have been paved, using Aztec asphalt under these specifications, which are now giving satisfaction, under a traffic which is classed as light to medium. The accompanying table gives data concerning these streets. The yardage given includes the granite and brick gutters, intersections, etc.

A number of streets are included in the printed city report in which Aztec and Bermudez were used together in about the percentage of Bermudez 60 and Aztec 40 per cent.

The city has under contract at the present time for early construction about 74,000 square yards of asphalt pavement.

Aztec asphalt has also been used in bituminous concrete streets on Augusta, Madison and Mosher streets to the extent of some 8,500 to 9,000 square yards.

| STREET. | Base. | —Asphalt— Top. In. | Binder. In. | Length. | Sq. yds. | Cost per sq. yd. |
|---|---|---|---|---|---|---|
| Castle, Fayette to Madison | 6-in. conc. | 2 | 1½ | 1,818.2 | 6,347.5 | $1.65 |
| Chester, Baltimore to Lombard | 6-in. conc. | 2 | 1½ | 285.0 | ..... | ..... |
| Collington, Orleans to Ashland | 6-in. conc. | 2 | 1½ | 1,748.9 | ..... | ..... |
| Conway, Sharp to Charles | 6-in. conc. | 2 | 1½ | 730.4 | ..... | ..... |
| Front, Gay to Hillen | 6-in. conc. | 2 | 1½ | 134.0 | ..... | ..... |
| Lanvale, Linden to Park | 6-in. conc. | 2 | 1½ | 645.8 | 2,884.6 | 1.65 |
| Lanvale, Madison to Eutaw place | 6-in. conc. | 2 | 1½ | 289.2 | 1,300.3 | 1.65 |
| Linden, Biddle to Dolphin | 6-in. conc. | 2 | 1½ | 1,189.2 | 2,470.8 | 1.70 |
| Lombard, Chester to Patterson Park ave | 6-in. conc. | 2 | 1½ | 1,189.2 | 2,470.8 | 1.70 |
| | Cobble | 1½ | 1½ | 701.4 | ..... | ..... |
| McCulloh, Lafayette to North | 6-in. conc. | 2 | 1½ | 3,410.2 | 14,393.6 | 1.65 |
| Montford, Baltimore to McElderry | 6-in. conc. | 1½ | 1½ | 140.0 | ..... | ..... |
| | Cobble | 1½ | 1½ | 1,892.6 | ..... | ..... |
| Mulberry, Monroe to Fulton | 6-in. conc. | 2 | 1½ | 447.4 | ..... | ..... |
| Park, Lafayette to McMechen | 6-in. conc. | 2 | 1½ | 787.1 | 4,046.7 | 1.65 |
| Richmond, Cathedral to Howard | 6-in. conc. | 2 | 1½ | 942.5 | ..... | ..... |
| West, Light to Riverside | 6-in. conc. | 1½ | 1½ | 906.2 | 3,203.9 | 1.65 |

## Sand Sprinkler for Smooth Streets

American cities are gradually coming to the point of sprinkling their smooth streets with grit at times when ice or fog make them slippery. Foreign cities have had this habit for some years and save many falls and much congestion of traffic thereby. The skidding of automobiles on streets in slippery condition is frequently a very dangerous occurrence and will be prevented by a light sprinkling of the grit. One objection to sand-sprinkling the slippery streets is the cost of putting on the sand and then taking it off, but our climate is dry for so much more of the time than that of London, for example, that we would not be obliged to do this sanding and sweeping up every day

for many days together as they do, and so the cost should be much less with us than with them.

Another reason for lower cost is found in such apparatus as the new wagon for sprinkling sand and gravel, made by Chas. Abresch Co. and sold by the Kindling Machinery Co. of Milwaukee, Wis. This wagon has a revolving disc with vanes on its upper surface which distributes the gritty material uniformly by centrifugal force as the wagon moves along. It is fed by a chute from the wagon bed above which is governed by a gate operated by a lever at the driver's seat, so that one man can drive and operate.

Milwaukee has one of the wagons which sanded three miles of pavement one day late in January and, according to one team owner, saved no less than $2,000 worth of horseflesh by the operation. At the First avenue viaduct the roadway was so icy that some forty loaded coal wagons could not cross until the roadway had been sanded. Such classes of evidence as these two demonstrate the economy of the sanding wagon.

The next problem will be to remove the sand when the occasion for it has passed and it is being ground into dust to be blown about. While this must be reckoned with, it is evident that the benefit from the sanding is far greater than the total cost with this subsequent removal added on.

## Park Fences of Artistic Design

An illustrated description of the construction features of the fences designed and manufactured by the Van Dorn Iron Works Company of Cleveland, O., was given in the January number of MUNICIPAL ENGINEERING. A view of one of the fences will be found elsewhere in this number. That the designs are popular and the construction is satisfactory is shown by the list of parks, cemeteries and like public and semi-public grounds in which they have been used. A few of these are noted as follows:

Maplewood Park, Rochester, N. Y., has 1,200 feet of fence 4 feet 6 inches high, using the ⅝-inch square picket, and 1,500 feet 5 feet high has been built around Highland Reservoir by C. C. Laney, the superintendent of parks. It has also been used around Mount Hope cemetery in Rochester. Another design is used for a playground which requires 1,500 feet, 6 feet high.

The National Volunteer Soldiers' Home at Los Angeles, Cal., is surrounded by 6,400 feet of one design, which is 6 feet high.

One popular design is used by several cemeteries such as the Fort Hill Cemetery Association, Auburn, N. Y., J. H. Woodruff, chairman, which uses 3,000 feet of it, 5 feet high. It is also used by state institutions such as the State Hospital for Insane at Warren, Pa., J. W. Greenland, steward, which is surrounded by 3,500 feet of 5-foot fence. Such corporations as the Burden Iron Co., Troy, N. Y., find use for a good looking as well as a good fence, that plant having in use 1,800 feet, 6 feet high, with the ⅝-inch square pickets. Park commissioners use a similar design, the board of park commissioners of Brookline, Mass., having 1,000 feet of the 5-foot fence in use under specifications of A. H. French, their architect.

This list can be indefinitely extended by the manufacturers, the Van Dorn Iron Works Company, Cleveland, O., who will on request send full information about the fences they manufacture, as well as the other iron and steel work which their plant is fitted to turn out.

## Police Signal System of South Bethlehem, Pa.

The city of South Bethlehem, Pa., has just begun the use of its new police signal system, which was installed at a cost of about $2,500 by the National Police Signal Company of Buffalo, N. Y. The system was installed under the direct supervision of its inventor, Louis W. Miller, and was thoroughly tested, the final tests being made Feburary 4, when the plant was accepted and put in operation. The construction was authorized about a year ago and some outside work was done early in the year, but Mr. Miller's work was done during the last two months.

The system of fifteen stations is operated by current supplied by batteries located at police headquarters, these being in duplicate so that one set is always ready for use. The batteries are charged from the alternating current used for street lighting thru the usual transformer.

Each station is on a separate circuit, so that trouble on it does not affect any other circuit. Fuses, automatic arresters of overcharge or lightning, etc., are ample, and trouble on a line is shown on the switchboard by its own red lamp, which remains lighted until the trouble is removed.

Each station is in a waterproof box and is supplied with a telephone, an emergency button, a loud ringing bell and a red lamp which is strong enough to be seen two miles. An officer can communicate with the central station by telephone and on occasion by pressing the emergency button, and the distress signal thus made will continue until the central operator responds by appropriate flashes of the light.

The bell and the light are to enable the central operator to call patrolmen to the box for communication with them. Any particular officer can be located in less than four minutes if he obeys his orders and is on regular duty. Any number of officers can be called at the same time. If the central operator is not in too great a hurry he can set a signal so that when the officer opens the station box to send in his report a whistle is heard which causes him to ask for the special communication.

Attached to the switchboard at headquarters is an automatic time recorder which registers the exact time a report is made and the box from which it is made. This recorder is locked and cannot be tampered with except by the holder of the key.

Mr. Miller added to his contract without charge a demonstrating box at headquarters containing all the apparatus in the outside stations, a motor-generator, a ringing motor-generator, an automatic controlling device and a "howler" circuit. A fire call to the fire department was also provided for.

The system is improved and perfected and is even more modern and complete than that installed by the same company in Buffalo, N. Y.

## Fifth Avenue Pavement in New York

The first modern pavement laid on Fifth avenue in New York was of granite blocks put down in 1886. For years it was considered the only pavement which would stand the traffic, but in 1897 a Trinidad asphalt pavement was put down on the continuous demand of the shopkeepers and residents for something less noisy than the granite blocks. This pavement was put on a concrete foundation and consisted of the cushion coat of broken stone coated with asphalt, which was then popular, and a 2-inch wearing surface of the regular Trinidad asphalt specification.

For sixteen years this pavement on the eight busiest blocks of the street, from Thirty-fourth to Forty-second street, has stood what is the heaviest traffic of any street in the world with but two or three exceptions and has worn down smoothly so as to keep its uniform wearing surface until it was in many places not more than one-fourth inch thick.

It became necessary, therefore, to resurface the street, and this was done in fifteen days' time last September. The area resurfaced is about 13,600 square yards, so that this is very nearly a world's record for speed of performance. Trinidad asphalt was used in the repaving on account of its excellent record under the rapidly changing and the increasing traffic of the past sixteen years, and the same method of construction was used as in the first pavement, except that the cushion coat was made more dense and becomes more nearly a part of the top coat, except that the stones in it are larger, so that it is an asphaltic concrete layer rather than a true asphalt pavement wearing surface.

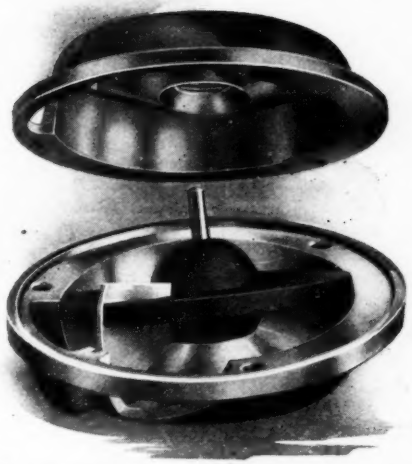
It is said that Fifth avenue has had so many concrete foundations put under it in the past that in some places the pavement base is from nine to twenty inches thick. This may well be true where it has been required that trenches dug in the street be thoroly filled and the concrete base of the pavement be thickened in replacing the pavement over the filled trench.

## Disk Water Meters in St. Louis

A recent paper by Fred L. Bock, of the St. Louis water department, before the Engineers' Club of St. Louis, gives a brief history of water meters in that city, beginning with the plunger meters in use in 1880. The rotary piston meter began to displace the plunger type in 1892. Later the disk and velocity types came in, and it it now the policy of the water department to give preference to the disk and velocity types.

The most popular meter at the present time in sizes smaller than 3-inch is the disk type, such as is made by the Buffalo Meter Company, Buffalo, N. Y., so called from the shape of its hard-rubber piston. The disk-shaped piston may be said to rotate or wobble about the ball and socket bearing at its center, as may be seen from accompanying cut. The chamber in which the disk mutates may be described as a portion of a sphere inclosed by the zone generated by the revolution of an arc about the diameter as an axis. There are two shapes of disk, one flat and the other conical. With a flat disk the top and bottom of the chamber are conical in shape and symmetrical. With a conical disk the bottom of the chamber is flat.

A diaphragm extending from the outer wall of the chamber to the ball of the disk at the center divides the chamber so that the water entering at one side of the diaphragm travels around the annular-shaped chamber, forcing the disk before it, and is discharged from the opening at the other side of the diaphragm. The two lines of contact between the disk and top and bottom of chamber divide it into four parts, of which two are continually filling and the other two discharging. This results in a continuous flow, and the volume displaced per revolution is the volume of the chamber minus that displaced by the disk.



DISK WATER METER, *open to show its simplicity and reasons for its durability.*

Impedance of flow is an important factor in meter design. At smallest rate of flow measurable by any type the impedance is negligible. The velocity type of meter impedes the flow least, but it is less accurate with low velocities. Next best is the disk type, which is accurate with low velocities, and this accounts for the popularity of this type as noted. The full capacity of the disk type can be regulated easily, within limits, by the relative size of inlet and outlet passages to the measuring chamber.

The disk type of meter maintains its accuracy well, generally 90 per cent. or better, until it fails entirely. The maintained accuracy can be explained by the fact that the wearing surface of a disk is concentrated at the ball and socket bearing. This affords only a small surface exposed to grit and slippage. When the wear in the bearing allows sufficient play, the edge of the disk will bind in the chamber and so cease to operate and probably break. These disks are quite cheaply replaced, and are very readily accessible for repair. The meter itself has low first cost.

## Refuse Disposal at Trenton, N. J.

The city of Trenton, N. J., in the process of modernizing itself which is going on under the commission form of government inaugurated recently, has taken up the question of refuse collection and disposal.

Last April an ordinance went into effect providing that garbage should be drained and wrapped in paper and collected with the refuse, to be burned in the existing Davis crematory. During one year previous the amount of refuse burned in the crematory was 18,349 tons, 270 pounds per head of population, the maximum in one day being 62 tons. To consume this refuse 275 tons of coal were required in addition to the combustible matter in the refuse. The total cost of operations was $6,632, or 48 cents per ton, not including deterioration or fixed charges.

The ashes were collected and dumped separately at a cost of 35 cents a ton for the 38,285 tons handled, dumping lands costing nothing and hauls being short and level. The weight of ashes per capita per year was 730 pounds, making the total of ashes, garbage and rubbish 1,000 pounds per capita per year.

Hering and Gregory, consulting engineers, New York, were employed to give a report upon the subject and to recommend a course of procedure for the future. Using the information as to population and amount of refuse disposed of and making an estimate of the probable increase in population, they recommend the construction of two 60-ton high-temperature destructor furnaces to dispose of the 123 tons maximum daily amount of all refuse probable in 1930. One of these furnaces would take care of the present daily product, and the other would be in reserve until such time as the amount increases to such an extent as to require the use of the second furnace for part time and ultimately for full time.

The high-temperature destructors such as the Heenan-Froude plants in the Borough of Richmond, New York City, Milwaukee, Wis., Atlanta, Ga., and elsewhere, are supplied with boilers, and the heat of the combustion produces steam in sufficient quantities to produce power for the uses of the plant itself with a residue which can be sold if the operation of the plant is sufficiently uniform to make the supply of power steady.

Trenton must pump its sewage, and it is proposed to equip the garbage destructor to supply the necessary power. It is estimated that the plant when run at the maximum rate of 123 tons a day will produce about 350 k. w. of current, whereas the power required for pumping sewage is about 275 k. w. Ultimately, therefore, the one plant can fully serve the other, tho the average run of the destructor plant will be about 60 per cent. of the maximum, and the maximum stated will not be reached for over 15 years under the estimate. Meantime some outside power must be provided to make up the deficiency or the collection of refuse must be stimulated.

Another source of revenue or conservation is the clinker produced by the destructor. Assuming 25,300 tons of refuse garbage and ashes as disposed of in 1930, the quantity of clinker estimated is about 5,000 cubic yards, which could take the place of that amount of broken stone now used in street paving, more than that volume being used for this purpose each year. Broken stone now used costs $1.83 a cubic yard, and the value of the clinker is estimated at $1. The present quantity of mixed refuse would supply about half this amount.

The engineers' report compares this kind of plant as to results with others and recommends the high-temperature destructor.

## Concrete Hollow Walls for School Building

The constantly advancing price of building materials and labor and the obvious need of fire protection in buildings, both public and private, makes timely an account of a method of construction that promises better structures at less cost.

The new school building of the Berkshire Industrial School at Canaan, N. Y., is not a fireproof structure, but is one of the highest fire-resisting types, and cost no more, or actually less, than the usual frame or brick and frame construction.

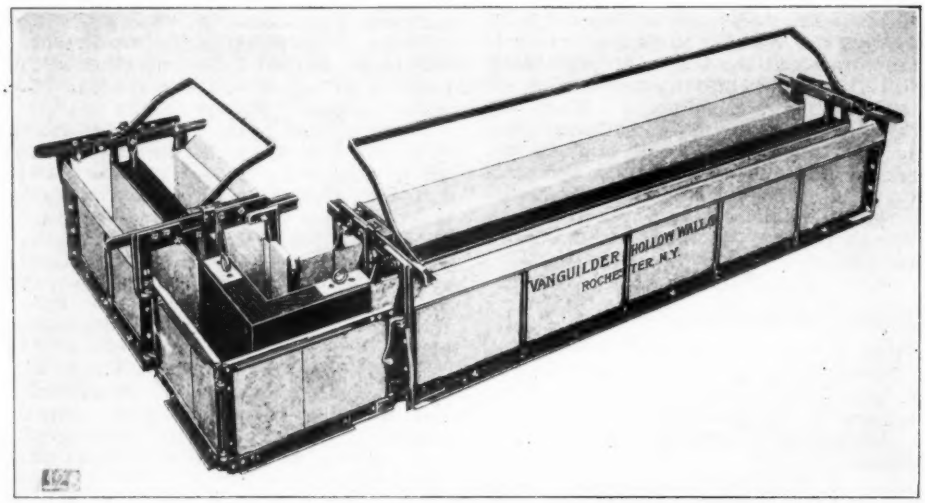
Some small buildings had been erected for the school the previous year by a comparatively new method of concrete construction known as the Van Guilder Hollow Wall System, using machines manufactured by the Van Guilder Hollow Wall Company, 734 Chamber of Commerce building, Rochester, N. Y., which consists of two reinforced concrete walls separated by a 2½-inch air space at every point, yet bonded by thousands of galvanized steel tires. This form of construction eliminates all form work and it dispenses with the use of building units, which means that the concrete is handled but once, and most of the work is done by unskilled labor.

The machine shown in the photograph is tamped full of concrete and the lever raised, which releases the machine. The machine is at once moved along and again filled, and so in a complete course around the building, the remarkable fact being that no interval of time is allowed for the concrete to set.

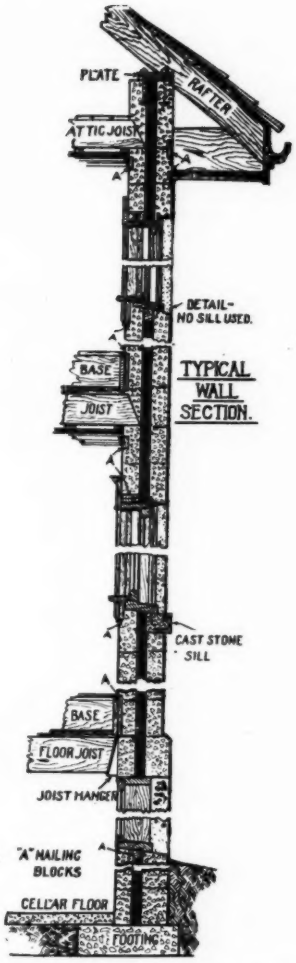
Provision is made for coupling two machines at the corners so as to insure jointless work, continuously reinforced; also for adjusting the machines to different wall thicknesses and for building in door and window frames in any desired position.

Both inside and outside surfaces of the rough wall are in effect scratch coated and form a perfect bond for plaster and stucco.

The outside walls consist of a 6-inch inside and a 4-inch outside concrete wall of bank-run sand and gravel mixed with cement 1:6 and reinforced with No. 9 galvanized wires in each wall 9 inches apart around the building. Over each opening, less than four feet, were placed two ½-inch twisted rods, and over the mullion windows were placed steel lintels consisting of two 7-foot channels bolted




MOLDS *for making Van Guilder hollow concrete walls, set for making corner.*




SECTION *of Van Guilder hollow concrete wall.*

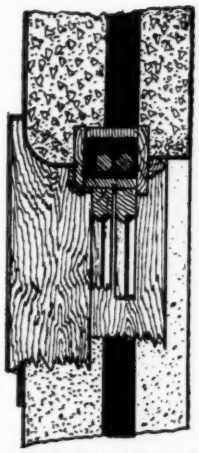
together with pipe separators and covered with wire mesh to receive stucco and plaster.

Two chimneys were carried up with the walls and each has two 10-inch round flues lined with vitrified flue lining. One also carries a 14-inch square vent flue ventilating kitchen and bakery.

The dimensions of the building are 48x80. In the basement are three storerooms, boiler room, two rooms for detention, common room for the boys and bath room with six shower baths and other toilet arrangements.

The first floor contains four dining rooms seating thirty boys, a sitting room for the staff and kitchen and bakery.

The second floor contains a large, airy dormitory for twenty-five beds, with toilet



DETAIL OF WINDOW TRIM *for Van Guilder hollow concrete wall.*

appointments. On the same floor there are six rooms for workers and one for guests, sewing room and bath rooms.

The third floor has a bath room and four rooms for the staff.

The floor and partitions have wood joists and studding, metal lath, plaster board and cement plaster, as shown in part in the typical wall section.

An interesting detail in line with modern sanitation is the elimination of wood trim, wherever practical, at a considerable saving in cost. All windows are finished as shown in the cut, corners being rounded in the rough wall and finished in plaster. The roof is of frame covered with green slate and the exterior of the building is finished with white stucco.

This building was erected by the school under the direction of Assistant Superintendent McClain. The actual construction was in charge of Mr. Chas. DeGroat, an expert representing the Van Guilder Company. The cost was considerably less than the building could have been erected for by other methods, and no other construction shows such economy in maintenance.

The architect is Mr. Cecil Evers, 184 Montague street, Brooklyn, N. Y.

## Goodyear Believes in Safety First

One hundred and fifteen factory foremen of the Goodyear Tire and Rubber Company, Akron, Ohio, have been organized into a compact and aggressive "safety first" battalion. This organization was perfected at a banquet presided over by President F. A. Seiberling of the Goodyear Company, and addressed by him and

other Goodyear officials, as well as other outside "safety first" experts of note.

Introducing the subject, President Seiberling said:

"During the past year 8,000 men have worked for Goodyear. During the coming year this number will be increased to 10,000. It is inevitable among such a multitude that accidents will happen. Goodyear foremen need to realize the necessity of safeguards and constant vigilance. This company holds the safeguarding of the lives and well-being of its employes as a high moral obligation."

Moving pictures showing safety devices and the danger of their absence illustrated various talks, and a squad was organized to patrol the 41-acre factory constantly, looking for dangerous operations, instructing workmen and suggesting safety devices.

Tho installed but a short time, the "safety first" organization has already caused a noticeable reduction in the number of minor accidents reported among the thousands of Goodyear workmen.

## How to Keep a Perfect Lawn

Two of the principal necessities of a permanently good lawn are frequent seeding and proper fertilizing. These have heretofore been difficult to secure without great labor, and then the results are liable to be uneven. A piece of apparatus intended to reduce the labor and increase the efficiency of lawn seeding and fertilizing is the "Velvetlawn" seeder, with its variation, the fertilizer sower.

The Velvetlawn seeder is made as a hand-power machine for putting greens for golf courses and for small lawns. A one-horse machine is made for use on larger areas, making new lawns or improving old ones.

The principle of the seeder is that of the disk plow, the disks opening trenches deep enough so that the seed, which is fed automatically by boots alongside the disks, drops into the deepest part of the trenches. The seeder may be equipped with individual automatic press wheels traveling behind the disks to close the trenches and press the seed down, or the water-weight roller is supplied, with which the green can be rolled both ways wtih the same result. The disks also have the effect of cultivating the grass roots. They are 2 inches apart on the hand machine, and by lapping half the width of the machine the rows of seed can be laid 1 inch apart.

The one-horse seeder is fitted with the automatic press wheels or with drag chains for smoothing the sod, or the roller can be used after the seeder has passed over.

The saving in grass seed and the saving in labor together far more than pay the cost of the roller in a season, if there is any considerable amount of lawn work to be done.

The Velvetlawn Seeder Co., Springfield, O., will send on request full information about the operation of the machine and valuable instructions on the care of lawns.

## Horse-Drawn Vs. Motor-Driven

OTTAWA, CAN.

"We have in very successful operation a motor-driven combination horse and chemical wagon which we placed in service August, 1911," writes John W. Graham, chief of fire department, city of

Ottawa, Canada. "This 6-cylinder 80-h. p. machine is proving most efficient and economical, as will be seen by the following expenditures for the department for the year 1912:

| | |
|---|---|
| New horses (annual estimates) | $1,500.00 |
| Horse feed | 5,220.00 |
| Harness repairs | 160.20 |
| Veterinary | 403.25 |
| Horseshoeing | 668.75 |
| Repairs to stables | 94.00 |
| Total cost for year | $8,046.20 |
| Cost of maintaining 46 horses per year | $8,046.20 |
| Cost of maintaining 1 horse per year | 174.91 |
| Cost of maintaining 1 horse per month | 14.57 |
| Cost of maintaining 1 horse per day | 46½ |
| Cost of maintaining 1 Seagrave combination hose and chemical truck per year, which includes gasoline, repairs, etc. | 126.48 |
| Cost of maintaining combination per month | 10.54 |
| Cost of maintaining combination per day | 34½ |
| Making a saving per day of | $0.12 |
| Making a saving per month of | 3.72 |
| Making a saving per year of | 44.64 |

CHARLESTON, S. C.

"The motor driven combination which we placed in service September 1, 1912, eliminated without loss of efficiency one chemical engine, one hose wagon and five horses and afforded a superior and more economical service," state Louis Behrens, chief of fire department, Charleston, S. C.

"This 80-h. p. Seagrave combination also serves as a tractor for pulling of a second size steamer, and its cost of operation from September 1, 1912, to August 31, 1913, is as follows:

| | |
|---|---|
| Cost of repairs, including labor and material | $36.80 |
| Cost of lubricating oil | 16.65 |
| Cost of charging batteries | 17.00 |
| Spark plugs | 7.00 |
| Cost of gasoline, 170 gallons | 28.94 |
| Total cost | $106.39 |

"The cost of operating and maintaining a horse drawn chemical engine, steamer and hose wagon for a period of twelve months, including forage and shoeing of five horses, averages $800, as against $106.39, cited above, thus making a saving of $693.61. The substitution of our motor combination for above listed pieces of horse-drawn equipment also eliminates salaries of three drivers at $900, thus effecting a saving in salaries of $2,700, or a grand total of $3,393.61."

ASHEVILLE, N. C.

J. H. Wood, chief of fire department, Asheville, N. C., furnished the following data on the operation of two 80-h. p. Seagrave combinations, each equipped with two 20-foot extension ladders, one 45-gallon chemical tank and 200 feet of 1-inch chemical hose:

From September 1, 1912, to September 1, 1913:

| | |
|---|---|
| Cost of repairs, including labor and material | $ 88.73 |
| Cost of lubricating oil | 10.82 |
| Cost of gasoline, 550 gallons | 88.00 |
| Total cost | $187.55 |
| Distance traveled | 487.2 miles |
| Cost per mile | $ 0.388 |
| Cost of horse drawn apparatus (same equipment) for same period | 915.50 |
| Cost of horse drawn apparatus per mile | 1.92 |

NAPA, CAL.

"We have in operation one piece of motor-driven fire apparatus, viz., an 80-h. p. Seagrave combination chemical and hose wagon," writes C. F. Otterson, chief of fire department, Napa, Cal. "This piece of apparatus has been in service for thirty-four months, answering 148 alarms. Its cost for this period, including spark plugs, batteries, lubricating oil, gasoline and waste, totals $44.50. This makes a total per month for upkeep of but $1.25, as compared with $24.00, the cost of horse drawn apparatus (same equipment) for same period. This motor combination has controlled 140 of the 148 alarms which it has answered, without outside assistance, at a gasoline consumption of 108 gallons, $16.50. The total cost of lubricating oil for above period is $2.50.

IOWA CITY, IOWA.

James J. Clark, chief of fire department, Iowa City, Ia., submits the following cost data based on the operation of a Seagrave motor combination chemical and hose wagon:

January 14, 1913, to October 1, 1913:

| | |
|---|---|
| Cost of repairs, including labor an material | $ 3.00 |
| Cost of lubricating oil | 7.00 |
| Cost of gasoline | 30.00 |
| Total cost | $40.00 |
| Distance traveled | 400 miles |
| Cost per mile | $ 0.10 |
| Cost of horse drawn apparatus (same equipment) and traveling same distance for same period | 240.00 |
| Cost per mile | .60 |

JEFFERSON CITY, MO.

John W. Case, chief of fire department, Jefferson City, Mo. (which city has no horse drawn apparatus), submits the following data on the operation of a Seagrave 80-h. p. motor combination chemaicl and hose wagon:

| | |
|---|---|
| Cost of repairs, including labor and material | $ .65 |
| Cost of lubricating oil | 2.00 |
| Cost of gasoline | 11.25 |
| Total cost | $13.90 |
| Distance traveled | 65 miles |
| Cost per mile | $0.213 |

## Market Place, Fort Wayne, Ind.

The illustration accompanying shows the Fort Wayne, Ind., market house, constructed entirely of concrete except roof, and extending for a block and a half along Barr street from the rear of the city hall one-half block to Wayne street, and entire block from Wayne to Washington streets. There is an entrance into each of these sections from Wayne street and into the longer section also one from Washington street, a pavilion being provided at each entrance. The two pavilions facing each other on the opposite sides of Wayne street are connected by steel arches, from which electric lights are suspended, and contain the market master's office, as well as the public toilet rooms. The entire length of the market is 450 feet and the width from curb is 26 feet 8 inches. The teams back up to these curbs, outside the structure, while the purchasers use the passage through it.

The pavilions are of the Ionic order of architecture. The capitals of the columns were cast in glue molds, as were also the lions' heads over the drinking fountains, while the other architectural features, such as rosettes, keystones, etc., were cast in plaster molds and set in place as the structure went up. The drinking fountains were cast in place, all pipes, etc., being previously placed in position. The walls of the pavilions were built upon a core of brick work, presenting an unbroken surface of concrete made of white sand and Medusa white portland cement, with an aggregate of birdseye or roofing gravel. When the forms were removed the surface was scrubbed with wire brushes, exposing the aggregate, and the general effect is very pleasing. The columns were cast in place in the same manner as the columns of the main entrance.

In the main part of the structure there are 54 round columns, and 2 square columns at the end next to the city hall. The round columns are 8 feet 9 inches high, each resting on an octagonal base which varies in height with the elevation of the ground surface. The shafts are 24 inches in diameter at the base and 21 inches at the top, and each is surmounted with a plain molded capital and square cap. These columns support the roof, and within the space inclosed by them are the tables used by the market men, and the passage way for purchasers.

Medusa waterproofing was used in all of the concrete to the extent of about 1½ or 2 per cent. of the amount of cement used. Twenty-four hours later the forms were removed and the surface brushed. In casting the columns long bolts were

CONCRETE MARKET HOUSE, *at Ft. Wayne, Ind., immediately behind the City Hall.*

imbedded in the top of them in the line of their axis, and protruding for some distance for the purpose of anchoring the roof to the columns. The caps of the columns were cast with circular openings in the center, thru which the bolts would pass, and after the caps had been accurately adjusted to place this opening was filled with concrete, this serving the double purpose of holding the caps in place and giving additional anchorage to the bolts. The roof consists of a framework of wood covered with red roofing tile. A concrete floor is provided for the entire structure.

The architects for the market building were Mahurin & Mahurin, and the general contractors were Borkenstein & Son, while the cement and waterproofing were furnished by Wm. Busching Supply Company, all of Fort Wayne, Ind.

## A Portable Plant Laying Asphaltic Concrete Pavement

The accompanying photograph shows the portable asphalt plant belonging to C. H. Atkinson, laying an asphaltic concrete pavement in Watertown, S. D., with which he completed 30,000 square yards of street in sixteen days.

The plant is 65 feet long, and is complete in every particular. It can be set up, ready for operation, or knocked down for transportation within a day. It will mix material for sheet asphalt, asphaltic concrete, Topeka specification or binder, and can be changed from one to another without causing any delay.

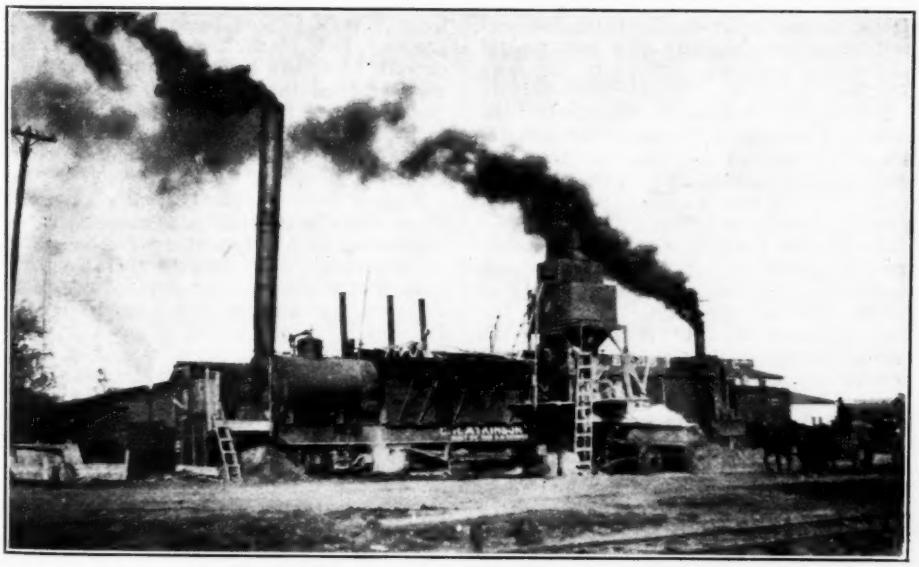
The plant was built by the F. D. Cummer & Son Co., of Cleveland, O.

## The Wylie & Hooper Refuse Destructor

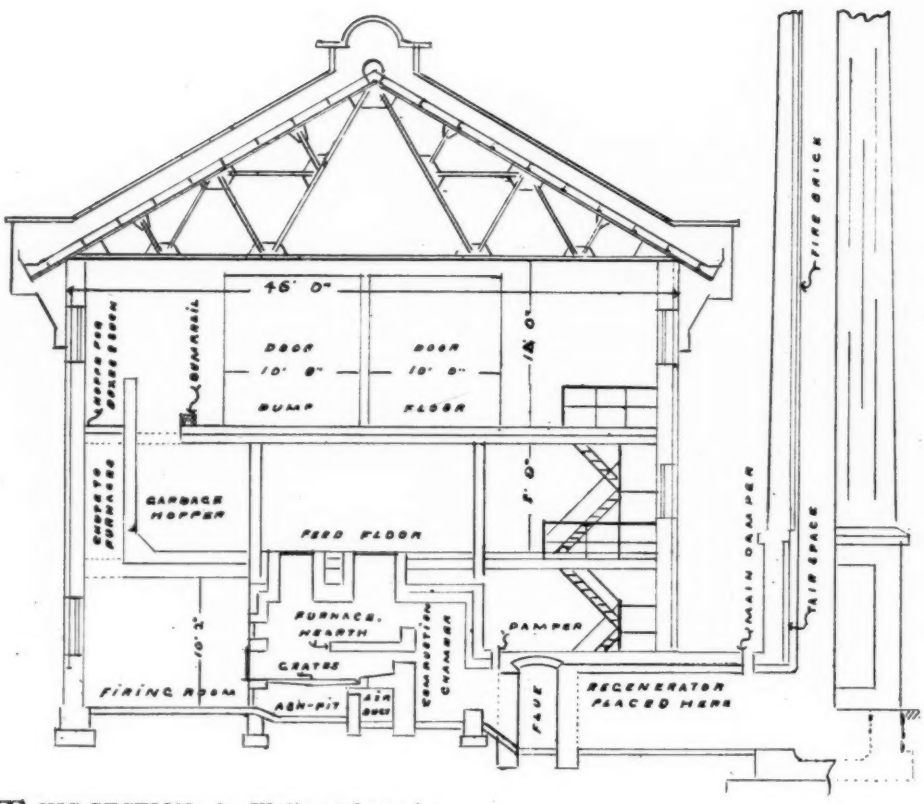
A new and improved type of destructor, for the purpose of destroying garbage, fruit, manure, and other town wastes, has recently been designed and patented in the United States by Messrs. Wylie and Hooper, of the city of Vancouver, B. C. This furnace has been designed by men experienced in destroying all classes of waste matter. Mr. Wylie has been superintendent of the garbage department for a number of years, while Mr. Hooper is an engineer of considerable ability and is in charge of the incinerator.

This destructor is designed to meet any and all requirements, whether in an isolated place with a few hundred people, or in a large city with 1,000 tons per day. The destructor can also be built to suit private institutions, warehouses or hospitals. Actual experiences have clearly shown the inventors of this furnace that in all cases local conditions must be considered and they govern the class of furnace that will be best suited. It is ordinarily useless to try and make conditions to suit the furnace.

This destructor is designed on the unit basis, each unit being entirely separate from the other and having its own combustion chamber, which discharges into a flue common to all. Each unit is supplied



CUMMER ASPHALT PLANT *of C. H. Atkinson, laying thirty thousand square yards of street in sixteen days at Watertown, S. D.*




THIS SECTION *of a Wylie garbage destruction plant shows clearly its construction and method of operation.*

with a damper between the main flue and the furnace, so that any unit may be cut out for any purpose, without in any way affecting the other. Considerable difficulty is found in staying or supporting the walls of furnaces, such as are in general use, when several cells or furnaces are joined together, but no trouble is found in this respect, where each individual unit is independently supported.

The drying hearth, which is over the burning grates and projects back to the combustion chamber, is one of the best hearths yet invented and is one of the main features of this invention. This hearth is so placed in the furnace that the radiated heat from its soffit destroys quickly the garbage placed upon the burning grates. This hearth is only used for material that is too wet for immediate combustion, such as fruit, etc. All material that can be destroyed without drying out goes directly to the burning grates and is there consumed.

The method of stoking the garbage as it is delivered on the burning grates is the opposite to that employed by most other designs. As the material drops thru the roof of the furnace it is deposited immediately behind the clinkering doors, whence it is pushed back on the burning grates. This method of stoking is much preferable to the usual method of pulling forward from the back of the furnace over the hot fires, as it prevents the stokers' tools from getting so hot, and the stokers are able to keep the fires more evenly spread.

These furnaces are of the high temperature type, having the air for combustion pre-heated and delivered under the grates by pressure. The inventors of this furnace do not recommend the use of steam boilers in connection with the garbage destructor. When the cost of installing the boilers and the upkeep of a staff of engineers is taken into consideration, the amount gained cannot in most cases meet the extra expense. The primary object of a destructor is to destroy garbage and other wastes. Anything that may be had by way of steam boilers being a side issue, the patentees of this furnace place but very little reliance upon.

The designs of the furnaces are modi-

Fifth Avenue, looking north from Washington St., Milwaukee, Wis. Treated with "Tarvia B".

# Milwaukee's Experience with Tarvia

Milwaukee has found that ordinary macadam is unsatisfactory under automobile traffic but that its resistance to wear can be much improved by the use of "Tarvia B". This material has been used on plain macadam and on streets which were built with tar binder and needed touching up.

The Superintendent of Street Cleaning, Mr. Charles O. Davis, writes:

> I am pleased to say that the results obtained from the use of this Tarvia are very satisfactory.
>
> We have applied this material on tar penetration streets which had begun to ravel, and find that with a very good covering of this material the ravelling was stopped. It gave to the road a nice smooth surface.
>
> Our experience also on waterbound macadam streets is satisfactory and the streets show up fine. One application sets up the surface, keeping out all water, with the result that the road is kept in good condition. It eliminates the dust nuisance as well.

"Tarvia B" is a special preparation of coal tar, which may be applied to the road either by hand or from some form of modern power sprinkler. The Tarvia percolates into the surface and hardens, forming a tough surface binder. The treated surface sheds water, resists ravelling and automobile traffic, and prevents the formation of dust. As a method of maintenance, periodical treatment with "Tarvia B" is inexpensive and highly satisfactory.

A more thorough method of preserving roads is to build them with Tarvia throughout, in which case the denser grades of Tarvia are used.

Booklet on request. Address our nearest office.

BARRETT MANUFACTURING COMPANY

TRADE B MARK

New York Chicago Philadelphia Boston St. Louis Kansas City Cleveland
Cincinnati Minneapolis Pittsburgh Seattle Birmingham
The Paterson Mfg. Co., Ltd.—Montreal Toronto, Winnipeg, Vancouver, St. John, Halifax, Sydney, N. S.

fied to suit the local conditions and the work to be done.

One furnace of two units has one unit for dry refuse and dead animals and the other handles garbage, fruit, and the like. The refuse, if dry, can be dumped thru one opening directly thru to the burning grates, on which it is deposited close to the clinkering door. It can then be pushed back so as to be distributed evenly over the grate bars, the rear of the fires being under the arch of the drying hearth. If the wastes are wet enough to require drying they are dumped thru a second opening in the top of the furnace onto the drying hearth from which the dried material not burned on the hearth can be pulled forward by rakes used thru the stoking door, to fall onto the burning grate below. A bridge wall behind the drying hearth separates it from the combustion chamber behind, thru which the burning and burned gases pass down to the smoke port and main flue to the chimney. Complete combustion is insured by the triple opportunity to consume the gases formed in the furnace. The flues are provided with dampers so that the direction of the gases can be changed as the use of the furnaces requires and the ducts leading the air to the furnaces lie along the main flues so that the air is heated before it reaches the fire and has a high velocity of movement.

A furnace for a small city with a single unit will destroy 15 tons of refuse a day and a double unit will destroy 30 tons. Such a furnace with steel stack and galvanized iron house over it has been built for $4,500. A side door above the level of the drying hearth is provided in this furnace so that wastes can be fed to the furnace by shoveling thru this door as well as dumping thru the openings in the top of the furnace. A hot water heater is provided in the combustion chamber, also, and a cleanout hole under the stack opposite the main flue.

A small furnace designed for use in hospitals and the like with a single unit can be built for about $1,000. Provision is made in the combustion chamber for the destruction of mattresses and such waste. This furnace can supply hot water or steam if desired. A feed door is provided on the side over the drying hearth and the clinkering door is also used as a feed door. An opening can be put in the top for feeding purposes if the location of the furnace permits. The air duct surrounds the combustion chamber on sides and bottom to absorb heat and increase rate of combustion. The steam or hot water pipes are located in the combustion chamber.

A still smaller furnace, which can be built for $600 and up, is designed for use in large stables, warehouses, department stores, and the like. It is quite similar to the hospital furnace and can be so placed that the wastes can be sent directly into the furnace from the various floors of the building without re-handling. It can also supply steam or hot water if desired.

Peter Wylie, 242 Thirteenth avenue, E., Vancouver, B. C., will supply any details of information that may be desired.

## Power from Garbage

A handsome advance catalog of the Harris garbage incinerator or destructor and power house combined has been issued by J. M. DeFord, 514 Penobscot Building, Detroit, Mich., which shows in perspective and by floor plans and sections plants proposed for Detroit and for Los Angeles, and the details of the design of the furnaces and boilers. The incinerator is designed for the destruction of mixed city wastes, such as garbage, rubbish, ashes, street sweepings, manure, dead animals and night soil, without odor or smoke and at the same time generating steam to drive dynamos or supply other power as desired.

## Dust Collectors for Machinery

Conservation of health of the worker and making his surroundings more cheerful is being recognized more and more each day as a most certain way of earning dividends. This is so because a healthy and cheerful worker does more and better work than the average.

Polishing work is receiving the atttention of health and factory authorities all over the country to the extent that some means must be provided for sucking away the dust, whether the amount of work to be done is large and the operation of the shop continuous or the quantity small and the operation of the shop only occasional.

Our illustration shows a new device of this kind. It will be noted that the blower or suction apparatus is directly underneath the bench in such a position as to create a powerful suction directly at the buffs. This constant stream of air draws in every particle of dust and deposits it in the tank shown. It is then subsequently removed, and if of value the latter is then easily recovered.

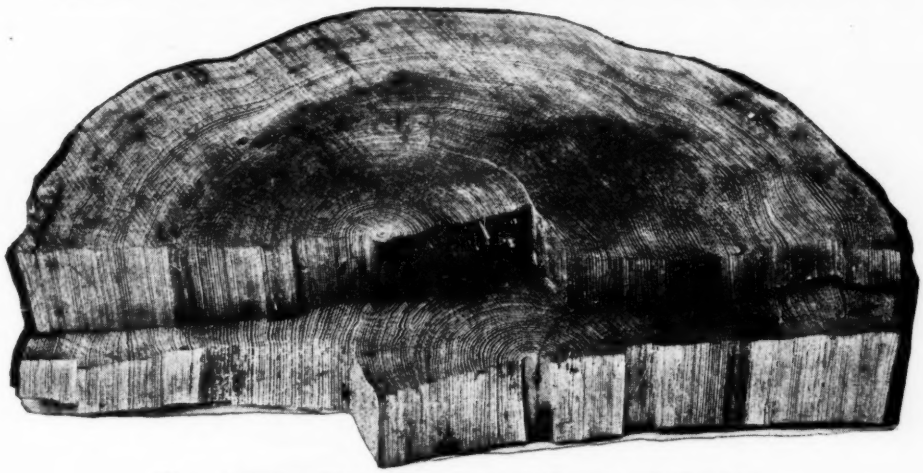
Many devices for the removal of the disagreeable dust particles have from time to time appeared on the market, but this one seems to embody to a greater degree than any of them the principle of efficiency with compactness.

Note also the clever way in which provision is made for polishing various classes of work. One side is equipped with a long spindle. This allows ample

# SOUTHERN YELLOW PINE

## THE BEST WOOD FOR CREOSOTED PAVING BLOCKS

**Because Its STRENGTH And SERVICE is NOT Affected BY CREOSOTING**



**Close Annular Rings, Dense, Hard, Strong and Durable.**

Mr. A. B. McFarland, Engineer of Tests, Atchison, Topeka & Santa Fe Railroad System, at Topeka, after making extensive and thorough tests with Southern Yellow Pine Timbers (Bulletin No. 149, A. R. E. A., 1912) states:

"The data shows conclusively that Long Leaf Pine timber which has been subjected to the full cell process of creosoting and allowed to weather for a year, ***is in no way inferior to untreated timber.*** When tested immediately after treatment, results show that treated timber to be slightly inferior to the untreated timber."

**No such statements concerning "other structural woods now commercially available" are to be found, notwithstanding standard tests have been made by qualified investigators.**

**"Best timber for engineering structures where great strength, long span and durability are required."**

**The facts are, *Southern Yellow Pine* has made "Creosoted Blocks" a popular paving material, owing to its *great strength under end compression, dense, hard texture and uniform straight grain.* The resin this wood contains is a preservation in itself, so that Yellow Pine blocks, when properly creosoted, will insure absolute paving satisfaction for *years* in the most trying, congested traffic districts of our largest cities, namely, New York, Boston, Chicago, St. Louis, Atlanta, Cincinnati, Detroit, Louisville, Memphis, etc.**

MR. ENGINEER: Hereafter be explicit. ***Specify "Southern Yellow Pine"*** for your next creosoted paving block contract. It makes an ***economical*** and ***desirable street pavement from every standpoint*** and gives ***longer*** and ***more efficient service*** for the money expended than any other pavement known to engineers.

***No royalties paid for its use, and no large repair appropriations necessary.***

**WRITE FOR LITERATURE AND INFORMATION.**

**Yellow Pine Manufacturers' Association,** 711 Wright Building, ST. LOUIS, MO.

working space for buffing on articles of considerable dimensions, such as trays, pitchers, silverware and articles of odd shapes. The hood over the buffs is of such construction as to allow the raising of the top and lowering the under section. This provides additional room for swinging these large pieces of work.

The opposite side has a short spindle, at which all small work may be easily polished and at the same time subjected to the powerful current of air which sweeps the dust particles into the lower dust tank.

A machine of this kind may be operated with the electric motor as shown, or it may be connected by a belt to an overhead shaft.

The principal feature of a machine of this kind, aside from its main one of removing the dust, is its compactness and power-saving ability.

Heretofore, when it became necessary to install a dust-collecting system, a great deal of figuring of sizes of piping, dimensions of suction blower, style of disposal tanks, etc., became necessary. With this machine, however, it would appear that all of this work has already been done, and the complete machine may be purchased all set up and ready to run.

It is only necessary to know that the machine will accommodate buffs as large as about 8 inches diameter by 2 inches wide.

One-and-a-half-horse-power motors are generally used, but small outfits are also supplied with motors as small as one-third-horse-power. Small work and lighter work, of course, can only be done with the smaller machines. It is surprising, however, to see one of the machines at work, to see the strength exerted at the buffs of even the smallest size machine, and, best of all, to note the power of the current of air that is sucked into the machine at the buffs.

Much work doubtless is yet to be done by manufacturers of this class of machinery before the ultimately perfect machine arrives, but until that time comes every factory, shop, college or manual training school, however large or small, should not overlook the desirability of securing a dust-collecting outfit for keeping their premises in a neat and presentable condition and at the same time to preserve health.

## Twenty-seven Carloads of Pipe Covering for New York's Municipal Building

The most costly municipal building in the world is practically completed, and New York has established another high-water mark in the raising of colossal structures. So enormous is New York's new home for its municipal offices that the quantity of material used in its construction reaches stupendous figures.

The ordinary visitor, for instance, would not guess that one contract alone for covering the vast maze of pipes which thread this building involves 27 carloads of pipe covering material.

The various lines covered include steam, hot water, ventilating, cold water and ice water for drinking purposes.

This contract was awarded to the H. W. Johns-Manville Company, New York.

## Hendricks' Commercial Register

The twenty-second annual Revised Edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. The total number of classifications in the book is over 55,000, each representing the manufacturers or dealers of some machine, tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. It has 1,635 pages, with upwards of 390,000 names and addresses. The book is revised, improved and issued annually. It is expressed to any part of the country on receipt of ten dollars. S. E. Hendricks Company, publishers, 74 Lafayette street, New York.

## Trade Notes

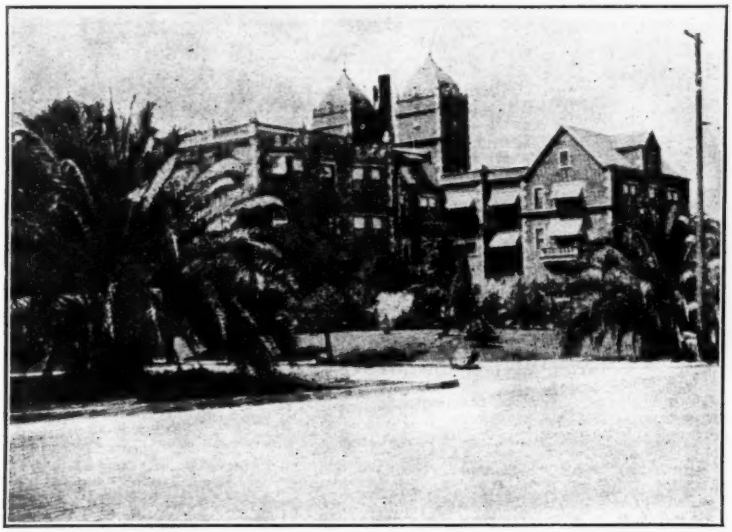
Contracts have been awarded the MacArthur Concrete Pile & Foundation Co., for the concrete pile foundations of the new Canadian Bank of Commerce building, Quebec, P. Q.; of the new High School of Commerce building, Springfield, Mass.; and a fifth contract for pedestal concrete pile foundations at the Canadian-Vickers, Ltd., ship building plant, Montreal, P. Q.

The Toronto branch of the Canadian Johns-Manville Company, Limited, announces its removal to more spacious quarters at No. 19 Front street, East. This new store and warehouse has a floor area of approximately 35,000 square feet and is situated in the heart of the wholesale district. In their new quarters this firm will be able to carry a larger stock and have ample space for the display of their complete line of J-M asbestos roofings, packings, pipe coverings, building materials, electrical and railroad supplies, automobile and plumbing specialties, etc. The entire building will be lighted by their well-known Frink and J-M Linolite System of Lighting and one room will be used for exhibiting these systems of lighting.

## THERE IS NO GUESSWORK IN THE CONSTRUCTION OF

# THE BITULITHIC PAVEMENT

It is made of varying sizes of the best stone obtainable, combined with Bituminous Cement, all of which is predetermined by laboratory tests to give the best results and gives the pavement density and "inherent stability" which makes the **Bitulithic** so popular.



Bitulithic Pavement, Wilshire Boulevard, looking west, showing Hershey Arms Hotel, Los Angeles, Cal.

## NOW IS THE TIME

You can't build roads in winter but you ***can*** decide what kind of construction to build your roads with next spring. The growth of **Bitulithic** is phenomenal. From a small yardage of 16,400 square yards in 1901 to over 30,000,500 square yards in thirteen years in over 300 cities throughout the United states and Canada, which is equivalent to over 1,700 miles of roadway 30 feet wide between curbs.

You should study the cause of this wonderful growth, and if you are a municipal official it is your duty to know. Your city should not stand in the background but should be in the advance line. It cannot be there without **Bitulithic,** "the pavement which is built up to a high standard and not down to a low price."

Prepare at once. It is to your advantage to make your contracts now, as 1914 promises extraordinary activity in the street paving line.

Specify **Bitulithic** and have a pavement that is endorsed by city officials and property owners alike; also highly recommended by automobile owners and drivers.

Write today for circulars and learn more about this modern pavement for modern cities.

# Warren Brothers Company

**EXECUTIVE OFFICES:**

**59 Temple Place, BOSTON, MASS.**

**DISTRICT OFFICES:**

| NEW YORK, N. Y. | CHICAGO, ILL. | ROCHESTER, N. Y. | LOS ANGELES, CAL. | PORTLAND, ORE. | PHOENIX, ARIZONA |
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| 50 Church St. | 10 S. LaSalle St. | 303 Main St., West. | 926 Calif. Bldg. | Journal Bldg. | 204 Noll Bldg. |

# CONTRACTING NEWS

## ROADS AND PAVEMENTS.

### BIDS REQUESTED.

Albany, N. Y.—March 6, until 1 p. m., for construction of sections of state highways, aggregating 70.59 miles. Certified check 5 per cent. of bid. John N. Carlisle, state highway commissioner.

Cincinnati, O.—March 6, until noon, for reconstruction of Geist road, from Big Four railroad tracks at Elizabethtown, to Cleves and Dugan Cap road; certified check, $3,000; for improvement of Powder House road, from south corporation line of Cincinnati, southeast to west corporation line of Cincinnati; certified check, $500. Fred E. Wesselman, president board of county commissioners.

Cincinnati, O.—March 13, until noon, for repair of Bridgetown pike, from Ferguson road to Five Points, at Muddy Creek; certified check, $1,000; for improvement of Campbell road, from Kilbey road west, 1,300 feet; certified check, $500; for improvement of Miami avenue, in Maderia, from Camargo pike to Shawnee road, certified check, $500; for improvement of Rose street, in village of Sharonville; certified check, $2,000. Fred E. Wesselman, president board of county commissioners.

Cleveland Heights, O.—March 16, until noon, for grading, draining, paving with brick, asphalt or macadam, and constructing sidewalks on Compton road, from south line of Mayfield road to north line of Euclid Heights boulevard; for grading Lee road, from Superior street to Fairfax road; for grading, draining, curbing and paving with asphalt, brick or macadam on Sycamore road, from Lee road to Ivydale road, Somerton road from Wilton road to Superior road, and on Euclid Heights boulevard, from Superior road to Lee road. H. H. Canfield, village clerk.

DeQuincy, La.—Until March 10, for constructing about 60,525 square feet of concrete sidewalk and 114,480 lineal feet of curbing. Plans and specifications may be obtained from mayor or T. H. Mandell, engineer, Lake Charles, La.

Grand View Heights, O.—March 14, until noon, for grading, draining and paving with macadam with bituminous surface treatment and constructing curbs and gutters of concrete on First avenue, from west corporation line to Grand View avenue; Broad View avenue, between First avenue and Goodale boulevard; Ashland avenue, First to Glenwood; Westwood avenue, First to Bluff avenue, and Paul avenue, Third avenue to Fifth avenue. Certified check, 20 per cent. of bid. V. W. Jones, village clerk, R. F. D. No. 5, Station A, Columbus, O.

Kokomo, Ind.—March 12, until 10 a. m., for construction of four stone roads in Howard county. E. B. Swift, auditor.

Racine, Wis.—March 7, until 10 a. m., for paving on Washington avenue, requiring 16,606 square yards brick paving, 6,854 lineal feet concrete gutter and 350 lineal feet concrete combined curb and gutter; for paving on North Wisconsin street, requiring 17,535 square yards brick paving, 8,112 lineal feet combined curb and gutter, 1,151 lineal feet concrete gutter; for paving Superior street, requiring 8,372 square yards brick paving, 4,141 lineal feet combined curb and gutter, 339 lineal feet concrete gutter. P. H. Connolly, chairman board of public works.

Silvis, Ill.—Until March 16, for paving six blocks on Eighth street, with brick. Wallace Treichler, engineer, Springfield; B. Walsh, mayor.

Struthers, Ohio.—March 11, until noon, for construction of sidewalks, crosswalks, curbs and gutters, during year 1914. Certified check, $100. Jonah Richards, village clerk.

Superior, Wis.—Until March 4, for repaving Ogden avenue, from North Third street to Belknap street. Materials—concrete, brick, asphalt and creosoted blocks. E. B. Banks, city engineer.

### CONTRACTS AWARDED.

Baltimore, Md.—To Baltimore Asphalt Block & Tile Co., for paving with sheet asphalt on several street in Northwest and West Baltimore. Bid, $109,334.90. To P. Reddington & Sons, for laying vitrified brick pavement on several streets, at total bid of $57,487.34.

Concordia, Kan.—To Watts & Ammerman, of Salina, Kan., at about $50,000, for construction of five blocks of vitrified brick and six blocks of asphaltic concrete pavement.

Corsicana, Tex.—To General Construction Co., of Ft. Worth, for paving certain streets with vitrified fiber brick, with asphalt filling on cement foundation. Bid, $52,000.

Detroit, Mich.—For cedar block paving as follows: Cavalry avenue, from Fort street to Dix avenue, J. A. Mercier, $21,066.82; Delaware avenue, from Hamilton boulevard to Merrill street, Julius Porath, $3,994.23; Hulburt avenue, from Charlevoix street to Mack avenue, J. A. Mercier, $12,585.79; Pennsylvania avenue, from Mack avenue to alley south of Gratiot avenue, Thos. E. Currie, $50,208.40. All are local contractors.

Evansville, Ind.—To John Fridy, of Evansville, for construction of rock road in Knight Township, Vanderburgh county at bid of $9,900.

Joplin, Mo.—To Ozark Paving Co., of Joplin, for paving Broadway from proposed viaduct to High street about 10,000 square yards with asphalt. Total cost $19,697.30. Bid $1.89½ per square yard. Boyd Construction Co. of Kansas City bid $1.90 per square yard.

Park Ridge, Ill.—To Boyd & Graziano, of Chicago, for construction of 37,500 square feet of concrete sidewalk. Bid $4,545.00.

Rockport, Ind.—To Bennett & Scamahorn, of Rockport, for construction of Armstrong township road, Vanderburgh County at bid of $8,310.

St. Paul, Minn.—To Chicago Creosoting Co., for about 144,080 yards of creosoted block paving in University, Hastings, Prior and Hamline avenues at bid of $1.25⅞ per yard. Other bidders were: Republic Company, $1.27¼; A. W. VanHafften, $1.287; Phil W. Herzog, $1.297; Kettle River Company, $1.365.

Winfield, Kansas.—To Elliott & Vance, of Parsons, for 32,000 square yards of paving. Bid $1.82 per square yard for standard brick block on 5-inch concrete base.

### CONTEMPLATED WORK.

Asheville, N. C.—30,000 square yards bitulithic, 2 miles street grading, 20,000 square yards cement sidewalks, and 12,000 lineal feet curb and gutter. B. M. Lee, city engineer.

Augusta, Me.—25 miles bituminous macadam roadway 16 feet wide, 5 miles cement concrete, roadway 16 feet wide, and 190 miles gravel roadway 21 feet wide. Paul D. Sargent, chief engineer, state highway department.

Barre, Vt.—5,000 square yards bituminous macadam, 3,000 square yards cement sidewalks, and 1,500 feet granite curb. H. Ward, mayor.

Bellingham, Wash.—Two miles of asphalt, three-fourths mile brick, 12 miles of either asphalt concrete or cement concrete,

# The Spirit of Service

WHEN the land is storm-swept, when trains are stalled and roads are blocked, the telephone trouble-hunter with snow shoes and climbers makes his lonely fight to keep the wire highways open.

These men can be trusted to face hardship and danger, because they realize that snow-bound farms, homes and cities must be kept in touch with the world.

This same spirit of service animates the whole Bell telephone system. The linemen show it when they carry the wires across mountains and wilderness. It is found in the girl at the switchboard who sticks to her post despite fire or flood. It inspires the leaders of the telephone forces, who are finally responsible to the public for good service.

This spirit of service is found in the recent rearrangement of the telephone business to conform with present public policy, without recourse to courts.

The Bell System has grown to be one of the largest corporations in the country, in response to the telephone needs of the public, and must keep up with increasing demands.

However large it may become, this corporation will always be responsive to the needs of the people, because it is animated by the spirit of service. It has shown that men and women, co-operating for a great purpose, may be as good citizens collectively as individually.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

AND ASSOCIATED COMPANIES

*One Policy* *One System* *Universal Service*

2 miles cement sidewalk and 2 miles of concrete curb and gutter. W. H. North, city engineer.

Buffalo, N. Y.—245,336 square yards asphalt, 31,343 square yards brick, 11,198 square yards sandstone, 14,379 lineal feet street grading, and 18 miles cement sidewalks. Louis P. Fuhrman, mayor.

Canton, Ohio.—13,830 square yards asphalt, 13.3 miles of brick, 72,652 cubic yards street grading, 46,590 square feet cement sidewalks, 146,240 square feet stone sidewalks, 9,250 lineal feet concrete curb, and 35,160 lineal feet sandstone curb. W. E. Sarver, city civil engineer.

Canton, Ohio.—70,000 square yards of brick and 70,400 square yards cement concrete, and 42,240 lineal feet concrete curb in Stark county. W. L. Bender, county engineer.

Dunkirk, N. Y.—14,134 square yards sheet asphalt, 3,581 square yards concrete, 9,000 square yards cement sidewalks and 12,000 feet concrete curb and gutter. H. B. Lyon, mayor.

El Paso, Ill.—10,000 square yards cement concrete road construction in Woodford county. A. B. Hurd, county superintendent of highways.

Galesburg, Ill.—9,000 square yards brick on concrete foundation and 38,750 lineal feet concrete curb. F. N. Connolly, city engineer.

Indianapolis, Ind.—Paving of Riley avenue, from Washington to New York street, and Bancroft avenue, from New York to Michigan street. Estimated costs, $14,461.00 and $7,559 00. B. J. T. Jeup, city engineer.

Lawrence, Kans.—20,000 square yards asphalt concrete, 20,000 square yards brick, and 7,000 square yards cement concrete. E. N. Bond, mayor.

Long Island City, N. Y.—20,000 square yards asphalt, 24,200 square yards asphalt concrete, 5,500 square yards bitulithic, 37,000 square yards granite, 14,000 square yards wooden block, 560,000 cubic yards road grading including 1,000 yards rock, 72,000 square yards cement sidewalks, 32,000 square yards stone sidewalks, 3,000 lineal feet cobble gutter, 14,200 lineal feet of highways in Queens county.

Los Angeles, Cal.—32 miles of asphalt and asphalt concrete, 2 miles bitulithic, .75 miles vitrified brick, 3.5 miles cement concrete, 25 miles gravel and oil, 3.5 miles macadam, 1.5 miles warrenite, 100 miles cement sidewalks, 81.5 miles concrete curb, and 101.4 miles of granite block gutter, cement concrete gutter and brick gutters. C. R. Brawner, city engineer.

Minneapolis, Minn.—25,000 square yards asphalt concrete, 25,000 square yards bituminous concrete, 15,000 square yards brick, 50,000 square yards cement concrete, 150,000 square yards wooden block, 30 miles cement sidewalks and 75 miles concrete curb and gutter. W. G. Nye, mayor.

Peoria, Ill.—15,000 square yards asphalt, 150,000 square yards brick, 2,000 square yards concrete, 10,000 cubic yards street grading, 12 miles cement sidewalks (private), and 10 miles concrete curb 6 inches by 22 inches. E. N. Woodruff, mayor.

Oakland, Cal.—Three miles asphalt, 12 miles oiled macadam, 20 miles surface oiling and screenings on old waterbound macadam, 25 miles cement sidewalks, 2 miles brick gutter, 2 miles cobble gutter, 12 miles concrete curb, 26 miles concrete gutter, and 18 miles wood curb. Perry F. Brown, city engineer.

Seattle, Wash.—12 miles asphalt, 6 miles brick, 25 miles sandstone, 20 miles street grading, 43 miles cement sidewalks, 1 mile wood sidewalks, 18 miles brick gutter, 20 miles concrete curb, and 2 miles granite curb. A. H. Dimock, city engineer.

Springfield, Mo.—39,000 square yards asphalt concrete, 67,000 square yards cement concrete, 21,000 square yards sarcolithic, and 27,000 lineal feet cement sidewalks, 47,000 lineal feet concrete curb, and 20,000 lineal feet limestone curb. George W. Culler, mayor.

Vallejo, Cal.—10,500 square yards asphalt, 100,000 square yards asphalt concrete, 5 miles cement sidewalks and 10 miles concrete curb. Lawrence Thompson, city engineer.

Wenonah, N. J.—9,857 square yards bitulithic, 39,000 square yards bituminous concrete, 7,000 square yards bituminous macadam, resurfacing 2 inches thick, 5,200 cubic yards gravel, 6,000 tons of stone, 22,000 cubic yards road grading, and 20,000 square feet concrete gutter. Wm. C. Cattell, county engineer.

## SEWERS.

### CONTRACTS AWARDED.

Appleton, Wis.—To Lamars & Grignon, of Little Chute, for sewer work. Bid 65c per lineal foot for 9-inch pipe, $28.00 for manholes and $1.65 for "Y" branches.

Lamoni, Iowa.—To A. A. Dobson Co., Lincoln, Neb., at $23,014.00 for construction of 30,000 feet of 8, 10 and 12-inch sewer pipe and Imhoff tank and three filter beds.

Tampa, Fla.—To Sullivan & Greeson for construction of sections 1, 2, 3, 5 and 10 of sewer system at bids of $58,800, $17,900, $28,413, $120,728.88 and $41,977.00 respectively; to Edwards Construction Co., for section 4 at bid of $33,500, and to McNeil, Davis & Webb for sections 6, 7, 8 and 9 at bids of $110,274.35, $81,166.75, $136,751.50 and $31,433.25.

### CONTEMPLATED WORK.

Ft. Wayne, Ind.—20,600 lineal feet 12, 15 and 18-inch vitrified pipe, 60 manholes and 18 catchbasins. Frank M. Randall, city engineer.

Galesburg, Ill.—2,000 feet of 12-inch sewer construction. F. M. Connolly, city engineer.

Minneapolis, Minn.—Five miles reinforced concrete and 20 miles vitrified pipe. N. G. Nye, mayor.

Seattle, Wash.—25 miles brick, 5 miles reinforced concrete, 20 miles vitrified pipe, 500 manholes and 750 catchbasins. A. H. Dimock, city engineer.

Springfield, Mo.—Twelve miles vitrified pipe and 225 manholes. Geo. W. Culler, mayor.

## WATER WORKS.

### CONTRACTS AWARDED.

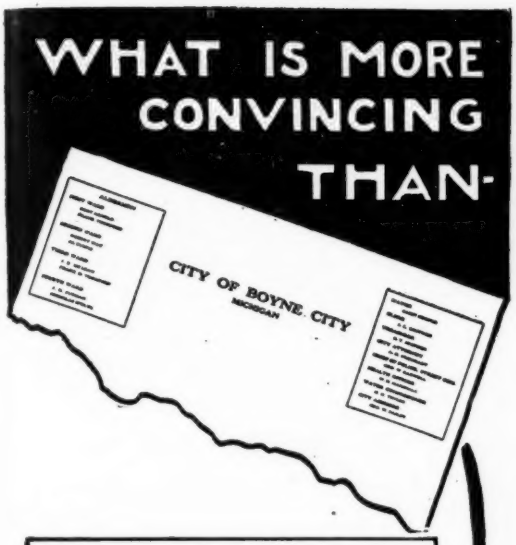
Manhattan Beach, Cal.—To Municipal & Industrial Equipment Co., of Los Angeles, for construction of municipal water system at about $111,000.

## BRIDGES.

### BIDS REQUESTED.

Cedar Rapids, Iowa.—March 9, until 10 a. m., for construction of reinforced concrete bridge to replace the present "B" avenue bridge, extending across Cedar river, from east bank of river at "B" avenue east, across the river to west bank at "F" avenue, and for removal of present steel bridge, foundations, etc. Certified check, $5,000. L. J. Storey, city clerk.

Hamilton, Ohio.—Until March 30, for construction of a 520-foot span bridge. Bid will be received on submitted plans, both on riveted steel truss bridge and a concrete bridge. Estimated cost $150,000. W. W. Crawford, Butler county auditor.




Dec. 11, 1913.

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Binghamton, N. Y.

Gentlemen:

We have been using your Forms for constructing sidewalks and curb and gutters for several seasons, and we have found them to be an advantage. Using lumber is a thing of the past for sidewalk forms, as metal forms can be used until they wear out and make us a more perfect job. Lumber warps out of shape after you use it several times.

Yours very truly,
J. L. EKSTROM,
City Clerk.

## Equipment *Earns*

**only when it is *active.***

Steel forms are released immediately and may be used again immediately, progressively with the work.

They can be set up in "jig-time."

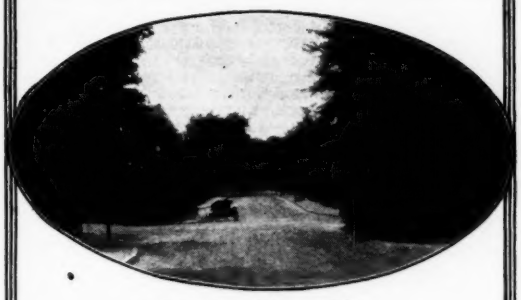
And further, they do not become *useless lumber.*

If you favor activity, act now and write for catalog.

We want active agents everywhere.

## Hotchkiss Lock Metal Form Co.

**BINGHAMTON, N. Y.**



Brookline, Mass.—1913.

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The use of Solvay Granulated Calcium Chloride is

## The Least Expensive Way

***Send for illustrated road book***

## Semet-Solvay Co.

**SYRACUSE, N. Y.**

Hamilton, Ohio.—Until March 30, for construction of a concrete bridge with an attached viaduct at Middletown, Ohio, over the Miami river. Estimated cost, $300,000. W. W. Crawford, Butler county auditor.

Knoxville, Iowa.—March 10, until 1:15 p. m., for construction of 90 reinforced concrete culverts and eight small steel bridges. J. D. Shlotterback, auditor.

Melrose, Minn.—July 17, until 8 p. m., for construction of a 100-foot steel bridge on concrete abutments. S. S. Chute, engineer, St. Cloud, Minn.

New Castle, Ind.—March 21, until 10 a. m., for construction of several arches and bridges and repair of others. P. H. Wolford, auditor Henry county.

Noblesville, Ind.—March 11, until 10 a. m., for construction and repair of a number of bridges and culverts in Hamilton county. W. O. Horton, auditor.

### CONTRACTS AWARDED.

Clarion, Pa.—To Whittaker & Dieht, Union Trust Bldg., Harrisburg, Pa., at bid of $16,997.00 for construction of a 325-foot 3-span reinforced concrete arch bridge over Clarion river.

Holcombe, Wis.—To Continental Bridge Co., Chicago, Ill., at bid of $3,574.00, for construction of a concrete bridge.

Roseburg, Ore.—To Cowlitz Bridge Co., of Portland, for erection of bridge across Cow creek. Bid, $2,197.20.

Sandpoint, Idaho.—To J. H. Forbes Co., Ltd., of Caldwell, Idaho, for construction of two steel bridges on Eastport-Addie road, at bid of $10,234.00.

Wharton, Tex.—To A. A. Alsbury & Co., of this city, for erection of a bridge at Glen Flora, at bid of $11,900.00, and of Spanish Camp bridge, at $2,280.00.

### CONTEMPLATED WORK.

Baraboo, Wis.—Four steel girder and ten concrete bridges in Sauk county. G. F. Post, highway commissioner.

Bethany, Mo.—Three steel truss, 18 steel girder, and five concrete bridges in Harrison county. John J. Werminger, county surveyor.

Benton, Mo.—Six or eight 10-foot arch concrete bridges. W. S. Murray, Scott county engineer.

Chattanooga, Tenn.—Plans have been accepted by city officials for the proposed reinforced concrete East End avenue viaduct and bids will be advertised for immediately so that work will be under way by April 1. Length of structure, 970 feet, width, 60 feet, and will cost approximately $70,000. Robert Hooke, city engineer,

Celina, Ohio.—Six steel girder and 30 concrete bridges. D. R. Smalley, county engineer, Mercer county.

Coalgate, Okla.—Six steel girder bridges in Coal county. I. L. Bowman, county surveyor.

Dana, Ind.—10 or 15 steel girder bridges ranging in length from 20 to 60 feet. H. Kaufman, county road superintendent and surveyor of Vermillion county.

Durand, Ohio.—Two concrete bridges 24 feet by 16 feet, in Pepin county. G. A. Goss, county highway commissioner.

El Paso, Ill.—Three steel girder and three concrete bridges in Woodruff county. A. B. Hurd, county superintendent of highways.

Freemont, Neb.—About ten steel girder bridges in Dodge county. John O'Connor, county clerk.

Galesburg, Ill.—Two concrete bridges. F. M. Connolly, city engineer.

Los Angeles, Cal.—One concrete bridge and two tunnels. C. R. Brawner, city engineer.

Minneapolis, Minn.—$900,000 will be expended on concrete bridges and $500,000 on viaducts for grade elimination. W. G. Nye, mayor.

Morrison, Ill.—One steel truss bridge and ten concrete bridges in Whiteside county. V. M. Taggett, superintendent of highways.

## AUTOMOBILES.
## FIRE APPARATUS.

### BIDS REQUESTED.

Montreal, Que.—March 26, until noon, for following apparatus: (a) One automobile salvage wagon. (b) Four automobile tractors. (c) Two automobile hose wagons. (d) One 85-foot aerial ladder, automobile truck. (e) One automobile fire engine, of a capacity of 1,200 American gallons. Further information may be obtained at office of Purchasing and Sales Agent, city hall. L. N. Senecal, secretary board of commissioners.

### CONTEMPLATED WORK.

Aberdeen, S. D.—One combination automobile truck will be installed after July 1, 1914. E. M. Hall, mayor.

Chickasha, Okla.—500 feet of hose will be purchased and probably a hose cart. Address J. V. Burton.

Ft. Wayne, Ind.—1,500 feet of hose will be purchased. Wm. J. Hosey, mayor.

Gary, Ind.—One auto chemical wagon, and one automobile for fire chief, and six motorcycles. W. J. Fulton, city engineer.

McKees Rock, Pa.—2,000 feet of hose will be purchased this year, and purchase of automobile fire apparatus and horse-drawn patrol wagon is being considered. Geo. H. McGinniss, city engineer.

Millville, N. J.—One auto chemical engine and hose cart. Appropriation $5,000. Newton B. Wade, city engineer.

Milwaukee, Wis.—One engine and one combination truck. Appropriations $10,000 and $5,500 respectively. Fred G. Simmons, commissioner of public works.

Philadelphia, Pa.—About $6,500 will be expended in replenishing hose. Three combination wagons, a repair truck, light wagon for repair purposes, and probably six motor patrol wagons will be purchased. Installation of 75 additional street fire alarm boxes is also contemplated. Geo. D. Porter, director of public safety.

Pomona, Cal.—$15,000 has been voted for purchase of fire apparatus. W. A. Vandergrift, mayor.

Pontiac, Mich.—One auto hose and chemical wagon. J. B. Austin, fire chief.

Vallejo, Cal.—One combination hose and chemical wagon. Lawrence Thompson, city engineer.

## GARBAGE DISPOSAL.

### CONTEMPLATED WORK.

Peoria, Ill.—Ten garbage wagons or carts will be purchased. E. M. Woodruff, mayor.

Saginaw, Mich.—This city and Bay City are considering the establishment of a joint garbage disposal plant midway between the two cities. H. H. Eymer, city engineer, Saginaw.

## BUILDINGS.

### BIDS REQUESTED.

Detroit, Mich.—Until March 10, for erecting Northeastern high school. Bids to be submitted on the work as a whole, or separately on masonry, carpentry, heating, plumbing and electrical wiring. Malcomson & Higginbothan, architects, Moffat building. Chas. A. Gadd, secretary board of education.

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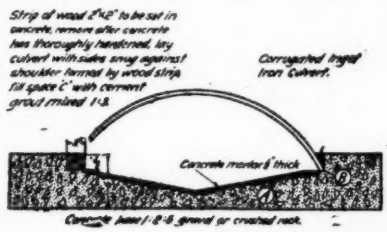
Strip of wood 2"x8" to be set in concrete, remove after concrete has thoroughly hardened, lay culvert with sides snug against shoulder formed by wood strip fill space ½" with cement grout mixed 1:3.
Corrugated Ingot Iron Culvert.
Concrete mortar 6" thick
Concrete base 1:2:5 gravel or crushed rock.

If a man knows absolutely that the material of the **Corrugated Iron Culverts** which he is offering will analyze 99.84 per cent **pure iron,** he is in position to back up his assertion with a surety bond.

## INSIST UPON HIS GIVING IT

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## YOUR PARK LAWNS SMOOTH and UNIFORM

The only way to obtain a smooth, velvety turf is to sow the seed in such manner that it will generate and grow to best advantage. Broadcasting the seed on the top of the ground does not accomplish this. The **velvetlawn way** places the seed far enough below the surface to insure its prompt and fullest growth. And it does it at

**HALF THE COST FOR SEED**

and a material saving in labor and time. It insures a luxuriant growth which will make Parks and Public Lawns withstand the wear of the golfer, the tennis player and the picnicker.

***Write for full description and prices.***

**Velvetlawn Seeder Company, Springfield, Ohio.**

**Our Horse Drawn Seeders are admirably adapted to spreading Calcium Chloride dust layers on Parkways or Highways.**

Fountaintown, Ind.—March 28, until 10 a. m., for erection of a two-story four-room brick school house with heating plant, etc. Charles M. Jackson, trustee Van Buren township, Shelby county.

Grass Creek, Ind.—March 14, until noon, for construction of an addition to Grass Creek high school. E. O. Weeks, trustee Wayne township, Fulton county.

Kingman, Ariz.—Until March 9, for erecting a court house. Probable cost, $70,000. J. W. Morgan, clerk, county board of supervisors.

Marshalltown, Iowa.—March 10, until 1:30 p. m., for construction of and equipment of school building in Liberty township Independent School District. Plans will be ready February 28. Certified check, $500. J. R. Howard, president, Clemons, Iowa.

Staples, Minn.—March 10, until 8 p. m., for construction of city jail. Certified check, 10 per cent. F. W. Findsen, city clerk.

St. Francis, Minn.—March 10, until 1 p. m., for erection and completion of a school building, also installation of heating, plumbing and ventilation. Plans may be obtained after February 18 at office of Kiby T. Snyder, architect, 751 Plymouth Building, Minneapolis. F. E. Vrooman, clerk board of education, District No. 12, Anoka county.

Sulphur Springs, Ind.—March 11, until 10 a. m., for construction of a high school building, also for heating and ventilating plant. Samuel Allen, trustee Jefferson township, Henry county.

### CONTRACTS AWARDED.

Bishop, Texas.—To C. B. Patterson, of Bishop, for erecting of main school building at bid of $39,293.00, and to Kendall & Jenkins for erection of three grade school buildings at bid of $12,100.

Lake Charles, La.—To McBride & McCammon, of Pine Bluff, Ark., at bid $20,718, for erection of high school at Benton, La., exclusive of plumbing, heating or electric wiring.

Monticello, Ind.—To J. C. Bardoner, of Reynolds, Ind., for construction of brick school building at bid of $14,706. Other bidders were James E. Barnes, Logansport, $16,999; Baker & Price, Logansport, $16,150; Hogshire & Young, Monticello, $15,930; Earl Wickersham, Logansport, $15,765.

### CONTEMPLATED WORK.

Columbia City, Ind.—H. A. Phend, architect of this city, is preparing plans for construction of new school house in Schrader district, south of city. Contract will be let about April 1.

Hartford City, Ind.—Elmer E. Dunlap, architect, 909 State Life Bldg., Indianapolis, is preparing plans for a new $40,000 addition to the present high school building on North High street. Work of construction will begin in the spring.

Rushville, Ind.—Elmer E. Dunlap, architect, 909 State Life Bldg., Indianapolis, has prepared plans for a 2-story school building for Walker township, Rush county, and bidders may see plans and specifications at his office.

## STREET SIGNS.

### CONTEMPLATED WORK.

Canton, Ohio.—6,000 enameled street signs. W. E. Sarver, city civil engineer.

Lawrence, Kans.—825 enameled street signs. E. N. Bond, mayor.

Martinsburg, W. Va.—200 cast iron 8-inch by 24-inch road signs for Berkeley county. H. H. Ness, county surveyor.

Minneapolis, Minn.—1,000 four-way street signs. W. G. Nye, mayor.

Oakland, Cal.—300 wooden street signs. Perry F. Brown, city engineer.

Penn. Yan, N. Y.—A number of concrete post road signs, two to each section in Yates county. Address M. McEvoy.

## MISCELLANEOUS.

### BIDS REQUESTED.

Cuba, Ill.—March 6, until 7:30 p. m., for a 60,000-gallon steel tank, brick pumphouse, 12x12 feet, and one deep well pump driven by electric motor or oil engine. Specifications on file with city clerk and Fuller-Coult Co., St. Louis, Mo., engineers. V. L. Durand, city clerk.

Manhattan Boro, New York City.—March 4, until 2 p. m., for furnishing and delivering 16 asphalt rollers. Marcus M. Marks, president of Boro, room 2034 Municipal Building.

### CONTRACTS AWARDED.

Indianapolis, Ind.—To Barber Asphalt Co., for 300 tons California B grade asphalt, price bid, $20.61 per ton.

St. Paul, Minn.—To Magnolia Petroleum Co., for 300 to 600 tons of asphalt at bid of $19.55 per ton.

### CONTEMPLATED WORK.

Los Angeles, Cal.—Purchase of one settling basin and one pumping station for sewage disposal plant. C. R. Brawner, city engineer.

Mansfield, Ohio.—Purchase of one settling tank, four septic tanks, and five filter beds for sewage disposal plant. E. A. Merkel, city engineer.

Philadelphia, Pa.—Replacements of pumps and boilers at Belmont pumping station are contemplated. Boilers to capacity of 3,000 h. p., and pumps to capacity of 30,000,000 to 40,000,000 gallons per day are under consideration. Geo. D. Porter, director of public safety.

Ford City, Pa.—Managers of Municipal electric light plant expect to erect a new power house and to install two 300 k. w. turbine driven units; also to purchase two 200 h. p. boilers, two 300 k. w. three phase, 60 cycle, alternating current generators, two 200 h. p. turbines, 3-panel switch board, complete with street lamp regulator for two circuits (100 250-watt tungsten lamps to each circuit), 50 40-foot poles, 8-inch top, 20,000 feet No. 4 weather proof wire, and 500 6-pin fir cross arms. W. H. Ellis, superintendent and chief electrician.

Harrisonburg, Va.—Installation of an auxiliary plant to cost about $12,000 has been recommended by J. M. Snell, chairman of electric light committee. It is proposed to install a large generator to be directly connected with one of the present turbine wheels or to a new wheel.